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AUTOMATIC MUSCULAR MOVEMENTS AMONG THE INSANE; THEIR PHYSIOLOGICAL SIGNIFICANCE.

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Recent physiological research recognizes the significance of the relationship between muscular movement and cell activity of the central nervous system. Hughlings Jackson has said "that the whole brain is made up of structures that subserve sensori-motor processes, and that into such processes all its functions may be resolved." Gowers likewise remarks "that every structure of the brain concerned with sensation proper is connected directly or indirectly with a part concerned with motion." These views have received fresh recognition and confirmation in Dr. Francis Warner's interesting volume on "Physical Expression," and in a recent article by the same writer in the *Journal of Mental Science*, April number, 1889.

This intimate relationship between functional activity of the central nervous system and muscular movement is well illustrated by Dr. Warren P. Lombard, in an article, entitled, "The Effect of Fatigue on Voluntary Muscular Contractions," which appeared in the *American Journal of Psychology*, January number, 1890. The interesting experiments made by Dr. Lombard demonstrated the fact that the fatigue attendant upon continuous voluntary muscular exertion, and the consequent periodical variation in the strength of voluntary muscu-

lar contractions is due to alterations "in some of the central nervous mechanisms which lie between the areas of the brain which originate the will impulse, and the centrifugal nerves." Although the nature of these alterations in the central nervous mechanisms is not explained, still the close relationship between automatic functional activity of the central nervous system and the muscular periphery is clearly established. Muscular movement, whether of the face or other parts of the body, represents cerebral cell activity. That mysterious property which, for want of a better name, we call nerve-force, is undoubtedly being constantly generated and stored up within the brain cells, and, upon the presentation of the proper stimulus, is as regularly discharged from them. The laws, which govern this elimination of nerve-force, are similar to the laws governing force in general. The great law of conservation of force or energy prevails in the field of cerebral cell activity as elsewhere. When chemical or other changes take place within the delicate nerve centres of the brain as a consequence of external stimulation through the senses, or internal stimulation following mental activity, the result conforms to the requirements of this universal law. Either the force generated by these chemical changes remains stored up in the cerebral cells as potential energy, to be called forth at some future time by stimulation, or it is transferred from the cells along the proper efferent tracts to the muscular system, and appears as motion. This is the physiological explanation of physical expression.

Now a certain constant and regular transmission of this nerve-force, from central cells to the muscular periphery, is natural and in accordance with a state of health. Indeed, a condition of what we call general good health demands this outward relief for the potential energy constantly accumulating within the brain cells. Thus the excessive muscular activity of all young and growing animals, the playfulness of young dogs and kittens, the pranks and follies of boyhood, are oftentimes merely the expression of this great natural law. In adult life, the potential energy of the cerebral cells is manifested in more practical and useful ways, but still in the more tangible results of a successful business, professional or

mechanical life, we recognize the outward manifestation of the potential energy which has been stored up within the brain cells until the proper stimulation called forth its discharge.

This intimate relationship between muscular movement and central cell activity within the cerebrum, has been discussed in Dr. Francis Warner's writings already referred to. This author calls attention to the fact that these outward manifestations of central cell activity begin at birth, and are witnessed in the countless random and meaningless movements of infancy, to which he has given the name of *microkinesis*. Undoubtedly, at a very early age, healthy inhibition of muscular movement begins. One by one useless and superfluous movements are checked, eliminated or co-ordinated in such a way that when adult life is reached, the individual, if in health, manifests those muscular activities which subserve the general purposes of the will and intelligence. Even at this period of life many movements remain fulfilling no particular purpose, but representing mere automatic cell activity, which has either been acquired by the individual or transmitted to him by heredity. The various movements and positions of the facial muscles, which, in their totality, make up the individual physiognomy, belong to this automatic and acquired class. Facial muscular action repeated in the same manner for months and years will, as Schack says, end by impressing "permanency and stability" upon those very lines which were at first only fleeting in character. It is undoubtedly in this mechanical way that heredity, the character of the social, intellectual, and moral life of the individual moulds the physiognomy, by continuous action of certain cerebral centres upon the terminal muscular expansions in the facial region. Facial expression, therefore, is only one of a large class of automatic and involuntary muscular movements that follow central cell activity within the cerebrum.

The close relationship between automatic muscular movement and the inhibitory power renders a study of the latter quite essential to a complete understanding of the subject of automaticity in health and disease. In health, this inhibitory power, which varies with individual growth and development, exercises a marked restraining influence over all mus-

cular movements that follow central cell activity, particularly all those movements that do not subserve a useful purpose. Exactly what this inhibitory power is, is still a question for physiologists and psychologists to determine. It is recognized as playing a most important part in the intellectual and physical life of man. Whether inhibition is a purely metaphysical attribute of mind or a special function having its seat in specific centres of the brain, its importance as a factor in the life of the individual cannot be doubted. Many writers have denied the existence of special inhibitory centres, and many physiological and psychological facts confirm their views.

G. H. Lewes, in "The Physical Basis of Mind," argues with much force against the existence of special centres of inhibition. He attempts to explain the phenomena of inhibition by what he calls the Law of Arrest. "The Law of Arrest," he says, "is only another aspect of the Law of Discharge, and may be regarded as the conflict of excitations." According to this theory, each nerve tract and centre possesses inherent inhibitory properties of its own. The strongest excitations prevail; "the discharge is only the resultant of the conflict along the line of least resistance, the arrest is the effect of the conflict along the line of greatest resistance."

Meynert advances the theory that the gray matter of the brain and cord presents a certain resistance to nerve conduction. Increased irradiation of any irritation is accompanied by increased resistance in nerve conduction. "It is evident, then," he says, "that inhibition, resulting from resistance introduced in nerve tracts, accompanies the simplest reflex processes."

This property of resistance may be increased by individual training and experience. The inhibitory power will, therefore, vary with the person; there is no universal inhibitory standard that can be applied to all alike. The most perfect inhibitory capacity is usually met with in those individuals that present a strong and healthy will power. Inhibition represents gradual growth, and varies at different periods in the life of the same individual. At birth and during early infancy, it scarcely exists. Every act that the infant performs is the impulsive and somewhat spasmodic response to sensory stimula-

tion. During childhood, the inhibitory power receives its first training and development. The child learns to govern himself. Experience and his parents teach him that the mere impulsive gratification of every whim that may arise, of every appetite that suggests itself, is not only not desirable, but may be fraught with disastrous results, both here and hereafter. In youth and manhood this power of inhibition receives constant education. The experiences of life all tend to develop it, if the will insists upon it. Finally, the inhibitory resistance, implanted in the nervous system in these various ways, is, to a certain extent, transmitted by heredity, so that those individuals, as well as races of men, present the most perfect manifestation of inhibitory power in whose ancestry this special faculty has been developed by training and experience.

Inhibition, therefore, seems to be a restraining power which is implanted in the mind, and incorporated as it were in the nervous mechanism of the individual. It is largely a matter of individual growth, and depends for its successful development upon the strong and healthy exercise of the will power. There is good evidence that inhibition is modified in various ways by climatic and hereditary influences. It is also evident that when once this inhibitory and restraining power is implanted within the nervous organization of an individual, its habitual and almost involuntary exercise is elicited by the presentation of the proper stimulus. Thus it is that habits and tendencies, which have only been repressed with the greatest difficulty and after the most active exercise of the will, receive frequent and comparatively easy restraint when once a tendency to their inhibition has been fairly established by the individual.

It is evident that this inhibitory power is intimately associated with all the higher faculties, and in common with them must seek expression through functional activity of the cerebral cortex. The inference is natural that functional or organic disturbance of this region should be attended by disordered inhibition. In health, the inhibitory function is exercised in a two-fold manner: *First*, in checking irrelevant trains of thought, repressing whatever is impertinent to the subject engaging the attention; and, *second*, in checking

certain muscular movements which, though they naturally succeed the stimulation that has preceded them, still for the time being and with other objects in view, are undesirable and out of place. It is with the general reflex motor disturbances, due to irregular and defective inhibitory action of the nerve centres of the central nervous system, that occur in the different phases of insanity, that this paper is chiefly concerned.

Normal muscular movement is the result of a certain transmission of nerve force from the central nerve centres along various efferent tracts to individual muscles. All such movements are either purposive in action, or, if involuntary, do not exceed the limitations established by health and which are recognized by all students of physical expression. Pathological motor activity, on the contrary, is spasmodic, irregular and purposeless. In diseased conditions of the brain, the pathological irritation of these delicate nerve centres may be so great as to overcome any acquired inhibitory resistance, and thus liberate an excess of nerve force, which will seek an outlet in the usual way by passing along efferent tracts to the muscles, and there appearing as muscular movements. Striking illustrations occur in cases of chorea and epilepsy. There seem good reasons for believing that in these diseases the brain cells are in an unstable condition, owing to hereditary, traumatic, or nutritive disturbances, and that, as Gowers says, the discharge of these same cells "may depend on the production of force within, being increased in excess of the resistance, or on the resistance being duly lessened."

In the functional and organic brain disturbance that accompanies insanity, pathological muscular activity and inactivity, are constant symptoms, and merit the careful study of the psychologist. The muscular disturbances of insanity are threefold, and represent three different central conditions.

1. *States of excessive nerve-muscular activity due to central irritation.* The constant muscular agitation of acute mania, *melancholia agitata*, the active stages of paretic excitement, and of many cases of recurrent mania, illustrate this form of motor activity. The central irritation is so great as to overcome all inhibitory resistance. The destructiveness, constant

pacing to and fro, jumping and running of patients of this class is an evidence of the purposeless, irregular, and spasmodic character of pathological motor activity due to morbid irritation of the central cells.

2. *States of deficient nerve-muscular activity due to central degeneration.* The general motor impairment that attends nearly all cases of permanent mental enfeeblement, and is witnessed in the slouchiness, feeble gait, and general helplessness of patients afflicted with terminal dementia, is an illustration of the deficient nerve-muscular activity that represents the degenerative processes occurring in the brain cells in nearly all cases of structural disease of that organ.

3. *States of automatic cell activity in the cerebrum, occurring not infrequently in acute insanity, and quite constantly in the chronic forms of the disease.* It is to this third form of pathological motor activity that this paper is especially limited.

The subject of automatic nerve activity is so well understood that any extended allusion to it would be superfluous. It has been a matter of frequent physiological observation that all nerve structure manifests a tendency toward automatic activity. This attribute, inherent in nerve tissue, is noticeable in the lowest forms of animal life, possessing only the simplest and most rudimentary suggestion of a nervous system. The ascidian, for instance, illustrates this peculiar mechanical and automatic action of a very simple organism that is wholly unprovided with anything like consciousness. The simple muscular movements that occur in this animal, upon the presentation of the proper stimulus, are entirely involuntary and reflex, and are always repeated in identically the same way during the life of the ascidian.

As we ascend the scale of animal life the nervous system becomes more complex; entire regions are specialized, one part becoming subordinate to another, until we reach man, in whom the completest subdivision and specialization has been attained. In him the higher centres in the anterior cerebral region preside over the nerve structures below in the brain and cord. Still even these more highly specialized

centres of the human brain manifest the same tendency to automatic and mechanical activity.

In one respect, however, man differs from the other forms of animal life. His *will power* presides over and directs those various processes which in the lower animals are automatic, instinctive, and largely involuntary. In man a few of the activities of organic life—such as respiration, the beating of the heart, and the like—are transmitted at birth fully established, and are entirely independent of the will. Other processes, such as walking, writing, and the like, are acquired after a most careful direction of the will, and laborious practice, and then become automatic. Still other higher processes, such as the psycho-intellectual activities of the individual, while under the guidance of the will, conform to the universal law of automaticity. Thought runs in certain well-established channels, and "Mechanism in Thought and Morals" is as susceptible of proof as the automatic action of the heart or the lungs during the processes of circulation or respiration—the only difference being that the intellectual and acquired activities are under the guidance of the will.

A high volitional power, therefore, distinguishes man from the lower animals. Even the most highly developed of these lower orders possess limited volitional power, while some would deny that they possess it at all. Many of their acts that seem to display a high degree of intelligence and to suggest the power of voluntary selection, prove, on closer examination, to be merely the result of unreasoning instinct that would not have admitted of any other course. In man, on the contrary, while his daily life is largely made up of various automatic activities, still the range of purposive selection is large, so that the "mechanism of thought and feeling" is made to serve the best interest of the individual through the guidance of the will.

In some way, at present obscurely understood, will power and functional activity of the cortex are mutually interdependent. Hence disturbance of these centres in insanity caused by impaired nutrition, defective functional activity, or more gross structural lesions weakens the will power of the individual. The functional activity of the cortical cen-

tres may be completely disarranged by insanity, and, as a result, the normal exercise of the will may be disturbed if not entirely suspended. At the same time, however, the activities of the basal ganglia, no longer under the guiding and controlling influences of the cortical centres, continue automatically. As a result, purposeless thought and action of an automatic character are quite apt to follow those serious disturbances of the higher cerebral centres during attacks of severe acute and especially of chronic insanity.

The inference is quite natural that in cases of extremely active acute mental disease and in a majority of the cases of terminal dementia, there is morbid disturbance of that region referred to by Dr. Lombard in the article previously cited: "the central nervous mechanisms that lie between the areas that originate the will impulse and the centrifugal nerves." In many cases of insanity that portion of the brain that "originates the will impulse" is cut off by reason of organic or functional disturbance, and consequently the areas that lie nearer the centrifugal nerves are left to act independently of will and inhibition. In Dr. Lombard's experiments these areas acted with a certain periodical variation, owing to processes of fatigue and recuperation; in cases of insanity this same region may display peculiar and persistent automatic activity by reason of cerebral excitation accompanied as it is with loss of function of the higher brain.

There is abundant clinical evidence in every hospital for the insane of this involuntary action of cerebral areas that lie between the centres originating will power and inhibition and the centrifugal nerves. In passing through wards containing the chronic and demented insane, one is struck with the evidence on every side of automatic activity. Here you will notice a man walking backward and forward in a mechanical way for hours together, until he has worn a beaten path in the floor; there will stand one who picks away at a certain place on his clothing for an indefinite period until he has worn the garment through to the skin. Quite frequently will be heard curious, meaningless noises, singular repetitions of words or sentences entirely meaningless. It is not an uncommon thing for a chronic patient to have some pecu-

liar word or phrase, or even a single articulate sound that he will repeat in an irrelevant way for years. In like manner you will meet with patients who make strange motions with the arms and hands, and maintain singular attitudes in a mechanical way. It is difficult to arouse the attention of such patients; their monotonous repetition of words and movements continues just the same regardless of the presence of others, and with little reference to any attempts made for their diversion. All this variety of automatic action and speech indicate that the healthy functional activity of the highest cerebral centres has been disturbed and partially suspended, and that other centres are acting in a mechanical manner and without the normal volitional and inhibitory control.

Prolonged automatic activity in thought, speech and action among the insane suggests a serious lesion in the higher brain. The more mechanical and purposeless the acts and words of the patient, the graver is the prognosis. The nervous system, indeed, manifests a striking tendency to mechanical repetition of any process once initiated within its centres. In health, habits and personal idiosyncrasy are illustrations of the facility with which automaticity is established in the central nervous system. The same tendency is equally noticeable in diseased conditions. One epileptic attack is likely to be followed by another, and a number of seizures renders the prospect of others quite certain, until in a short time the disease becomes firmly established. Both mania and melancholia manifest tendencies to repetitions of the attack, and each new attack renders the probability of another quite certain, until recurrency or permanent insanity is established.

It is when the inhibitory and volitional functions of the higher brain are suspended, and when unrestrained and undirected action occurs in those centres that are nearest to the outgoing motor tracts that the most peculiar evidences of automaticity are witnessed. In the advanced stages of fevers, such as typhoid and scarlatina, the higher functions of the mind are often suspended, either from exhaustion or because the cortical centres have been disturbed by the severity of the febrile action. In these grave physical conditions the auto-

matic and purposeless repetitions of words and muscular movements becomes quite noticeable. *Subsultus tendinum*, *carphologia*, tiresome utterance of some particular sound or word indicate that the higher cerebral functions have been suspended and that the lower centres are acting as it were at random and without the direction of the former. In this case the prognosis is grave because the vital forces themselves are waning and volitional activity is suspended through exhaustion of the cortical centres.

In chronic insanity the prognosis as to mental recovery of the patient may be equally grave, for the reason that healthy functional activity of the cortex has been permanently disturbed by the disease, which, though not necessarily fatal to life, is most assuredly so to mental restoration. The chronic insane are extremely liable to develop objectionable habits for the physiological reasons suggested. The special study of the physiological causes that underlie the peculiar habits so frequently met with in individual cases of insanity is both interesting and instructive.

Two laws underlie every form of nervous activity, and furnish a physiological explanation for the tendency toward the formation of strange habits and a certain automaticity in conduct and speech that is so frequently exhibited by the chronic insane, in whom it is to be remembered inhibitory impairment always exists.

1. The discharge of the nerve centres occurs along those tracts that offer the least resistance.

2. The more frequently the discharge occurs along a given line, and the weaker the inhibitory resistance, the easier does a repetition of the discharge become, and the more certain its permanent automatic establishment.

If, for instance, in those conditions of mental disease characterized by a weakening of the will power, one especial route is, for one reason or another, established on account of some delusion or mere fortuitous circumstance, the probability is that this particular route will continue to be the one most frequently traversed by nervous force in its passage from the brain to the periphery. A delusion, an hallucination of sight or hearing, some peculiar condition in the patient's environ-

ment may have first initiated certain actions which, by being unresisted and hence repeated, lead to the establishment of a habit. Probably in some such simple and purely fortuitous way are developed the pulling out of the hair, tearing the clothing, walking in a beaten path, making singular motions or uttering meaningless sounds; in fact, any of the strange habits of the insane. It matters little whether the performance of these habits is painful or disagreeable; no other alternative seems open to the patient when, through weakness of will and intelligence, the morbid route has once been established. Some morbid sensation in the scalp or chin to act as an excitor, or merely the absence of anything of an intelligent character in the mind to engage the attention, may lead to the plucking out of the hair or beard, which impulse, meeting with no resistance, soon developes into a persistent habit. A delusion about the bed may lead the patient into the habit of standing up all night, and, if not interrupted, nothing short of restraint will prevent exhaustion, so persistent will the impulse become to remain on the feet.

The importance of the early breaking up of bad habits among the insane will be readily understood. Fortunately, the same tendency to automaticity of action may be utilized in a good as well as a bad direction. By careful supervision, we may succeed in breaking up many useless and vicious habits by supplying some simple mechanical occupation for the hands, thereby utilizing the automatic nerve-activity characteristic of the disease. And in doing this, we may even seem to retard mental deterioration. Judiciously selected mechanical employment among the insane has become, therefore, a valuable means of treatment.

Strange postures, cataleptic attitudes among the insane, particularly those singular positions assumed by patients manifesting that particular group of symptoms, to which the name of *katatonia* has been given by some writers, possess the same interest for the psychologist as do the peculiar habits just mentioned. The significance of postures in health has been ably treated by Dr. Francis Warner in an article on "Muscular Movements in Man" in the *Journal of Mental Science* for 1889, April number. He says: "Postures depend upon the

ratios of nerve-muscular action, and to some extent they indicate the present ratios of static efferent force proceeding from the centres concerned. Observations show that the postures when not due to a present stimulus, or when produced by a weak stimulus from without, such as a sound or sight, correspond to and are signs of the general condition of the central nervous system." These remarks are particularly applicable to the singular attitudes seen in different cases of insanity. The postures that are oftentimes maintained for long periods by the insane are a pretty sure index of profound morbid disturbance of the central organ of innervation. Cases of *melancholia attonita* and chronic dementia afford the most frequent illustrations of morbid posture. The fantastic attitudes frequently associated with these two types of mental disease are undoubtedly due to the suspended functional activity of the higher brain. In melancholia this suspension of function may be only temporary, while in dementia it is permanent on account of structural changes that have occurred in the nervous centres. In stuporous melancholia the ideational centres appear to be almost functionally inactive. Either they are incapacitated by shock or impaired nutrition consequent upon a deteriorated state of the blood, or the slight activity they do retain, is restricted to the evolution of a single morbid and overwhelmingly insistent idea. The result is imperfect and misguided motor activity noticeable in perverted and meaningless posture. The condition itself, even though it is of recent date, is a serious one, and the prognosis is necessarily surrounded with doubt. So profound a disturbance of normal function in the ideational centres renders permanent instability of this region extremely probable, if it is not fatal to life itself.

The study of morbid postures among the insane is a subject of great psychological interest. The careful investigation into the early development of mechanical attitudes and movements, and meaningless habits among the insane, would amply repay the time and labor expended in this direction, and throw some light on the processes of cerebration and their connection with muscular movement. Quite frequently a single morbid dominant idea induces the patient to assume a peculiar attitude; to this attitude no opposition is presented through the damaged

inhibition and volition, and, in a short time, the posture becomes permanent by reason of the continued transmission of efferent force along this particular route. So insidiously are these postures developed that before the physician is aware of it, they have become established, and the real causes that lead up to their final establishment are lost sight of. Among the chronic delusional insane that are well-advanced toward terminal dementia, a single active delusion leads to a peculiar posture or movement; this soon becomes permanent because the motor impulses, originated by the morbid insistent idea and having met with no resistance, continue to pass along this particular efferent route until automaticity is established. The original idea that initiated the posture, in fact, all active ideation, may cease as a result of the brain disease, and yet the peculiar motor condition will persist.

Case II, represented in the plate at the beginning of the article, illustrates an attitude taken by a young man suffering from melancholia with stupor. At the time the photograph was taken, the patient was laboring under a second attack of the same disease, which proved fatal in the course of a few months. He would stand in the posture represented both day and night unless held or restrained. His position was constrained and tense, usually one side a little more elevated than the other, his arms and hands maintained in a rigid position, and all his facial muscles in a state of extreme tension. This position was taken in a very early stage of his disease, at a time when it was possible to elicit a few ideas from him. In reply to the question why he maintained this uncomfortable posture, he replied that he felt positive his bowels would be more certain to act were he standing rather than seated or lying down. When asked to sit in a chair, he always protested, saying that he could not do so, and it was only by the exertion of some force that he could be induced to take a seat. His position, if seated, was one of intense constraint. Generally, he would only half sit in the chair resting one thigh, and apparently partially holding himself up with his feet or hands. These peculiar postures were undoubtedly maintained partly by the intensity of his delusion and partly by the failure of inhibition to restrain nervous energy from taking the particu-

lar efferent routes suggested by the morbid reasoning. Had this case entered a state of dementia secondary to his acute insanity, we might expect to see these same attitudes and movements continued in a mechanical and automatic manner long after the active delusion which first instigated them had ceased. Nerve-muscular activity having traversed the efferent routes leading to these particular groups of muscles, and having for so long a time met with weak resistance, it results that this route becomes permanent, as well as the easiest, and in this way a morbid posture is established. Should we see for the first time such a posture as is represented in Case II after it had been established many years, we should find an explanation extremely difficult. But had we been able to trace its gradual development from the active delusions of an acute insanity, we should quite readily understand the peculiar attitude and its relation to the mental condition at the present time.

Case I represents a peculiar posture that was maintained for hours by a patient laboring under an attack of melancholia with stupor. This young man made no remarks; he kept his eyes tightly closed so that the secretions would accumulate under the lids; he would stand or sit in a rigid position with his head thrown far back on his shoulders, and any effort to induce a change of posture met with firm resistance.

Cases III and IV show singular and uncomfortable attitudes occurring in conditions of chronic terminal dementia. The postures were gradually assumed by the patients while under the writer's care, and yet so very slowly were they initiated that they became fixed and habitual positions before any especial attention was called to the fact. In this way the real causes that led up to the final establishment of the habitual posture were lost sight of. From what was known of Case III, the impression would be readily formed that the patient, owing to delusions of suspicion or fear, or a dislike to seeing persons about, gradually acquired the habit of hiding the face, as is often witnessed among timid and bashful children. As this particular case became more demented, a position which was at first assumed as the result of an active delusion, finally developed into a permanent habit, simply because ner-

vous force flowing along this route from centre to periphery for so long a time in obedience to impulses derived from morbid ideas and meeting with little inhibition, continued to take this route long after active thinking had ceased.

Another interesting fact concerning these strange attitudes is the apparently analgesic condition of the patients themselves; they all seem utterly oblivious to the discomfort and even the painfulness of these constrained positions. Case IV would maintain the posture shown in the picture for hours continuously; and Case III, from the hour of rising until bedtime, was continually in the attitude shown in the photograph. That these postures would be painful to a person in health, any one can demonstrate by attempting to maintain similar positions for even a few minutes at a time. The muscles concerned in the maintenance of these postures were in a high state of tension, showing that a certain amount of "static efferent force" was being transmitted continuously from the centres within the sensorium to the periphery over these morbidly pre-established routes. Nearly all the healthy activities of mind appeared in these cases to have ceased, and there seemed little left beside the mere processes of organic life; apparently, the entire energy of the sensorium was expended in keeping up these automatic and useless positions. Any attempt to move the arms into a more easy position was met by a firm resistance, which was not spasmodic, but persistent in character.

In conclusion, it may be said that automatic activity of the cerebral centres in health is quite largely under the direction of volition and inhibition, and the result is motor activity that is purposive. Automatic activity of these same centres in disease of the mind seems to be less under the guidance of the inhibitory power and the will, and the resulting action appears purposeless. In proportion, as inhibition and volition are weakened by the brain disease, to just that extent do meaningless automatic activities prevail. Inhibition and volition both being identified with healthy functional activity of the highest centres in the cerebral cortex, it naturally follows that varying degrees of automatic muscular movement will characterize some acute and nearly all chronic insanities.

THE PSYCHOLOGY OF TIME.

By Herbert Nichols.

I.—Historical.

In the history of language, words for 'time' are long preceded by words for 'past,' 'present,' and 'future,' and in myth and philosophy, Time makes a late appearance. The early Greek philosophers, even Parmenides and Heraclitus, naïvely took it for granted. Yet in this period questions were discussed that involved time; it is certain that the speculation of Pythagoras regarding number, descended with direct formative influence upon Aristotle's philosophy of time, and problems like Zeno's of Achilles and the tortoise, turned attention critically toward time.

All of previous philosophy is said to be summed up in Plato. I have discovered nothing more indicative of the status of time philosophy in Plato than the following found under 'time' in Day's "Analytical Index" of Plato's Dialogues (London, 1870.) "Time is the image of eternity (Tr. ii, 341, 342; Tim. 37 D, E; 38 A, B, C, D, E; Tr. vi, 155; Tim. 97 C);[1] belongs wholly to generation (Tr. ii, 338; Tim. 35, B, C; 36, A); is measured by the movements of heavenly bodies (see references above); time to depart and die (Tr. 129; Apol. 42, A); time is short compared with eternity (Tr. ii, 298, 186; Rep. 608, C; 498, D; see references in Stallbaum); time is nothing, and is not deserving of the solicitude of an immortal being (Tr. 298; 608, C); time and tune synonymous with good education (Tr. ii, 96; Rep. 413, D)." Time, *per se*, is nowhere psychologically contemplated by Plato; his nearest approach is in the Timæus as above. Time is not one of his five categories given in the Sophist, (being, rest, motion, sameness, difference). He conceived that motion was given to things because necessary to change; to the Kosmos alone was given rotation in a fixed circle, this being

[1] "Tr." refers to translation in Bohn's Classical Library; numbers and capital letters refer to the register of Ast and Stallbaum.

"the movement most in harmony with reason." With the rotation of the Kosmos began the course of Time — years, months, days, etc. Anterior to the Kosmos, there was no time, no past, present and future; no numerable or measurable motion or change. The ideas being without fluctuation or change, existing *sub specie æternitatis*, had only a perpetual present, no past or future; along with them subsisted only the disorderly, immeasurable movements of Chaos. The nearest approach which the Demiurgus could make in copying these ideas, was by assigning to the Kosmos an eternal and unchanging motion, marked and measured by the varying positions of the heavenly bodies. For this purpose the sun, moon, and planets were distributed among the various portions of the Circle of the Different, while the fixed stars were placed in the Circle of the Same, or the outer circle, revolving in one uniform rotation, and in unaltered position in regard to each other. The interval of one day was marked by one revolution of this outer or mo t rational circle, etc. . . . The phenomena of vision and hearing are included among the works of reason, because the final cause of these higher senses is to give men perceptions of number through contemplation of the measures of time. . . . An eternal sameness or duration, without succession, change, generation or destruction, this passes into perpetual succession or change, with frequent generation and destruction, into time.[1] This is the most specific conception previous to Aristotle, but it is really the naïve idea of time interwoven with Plato's doctrines of creation. In later philosophers the problems of time and memory are closely involved, but for Plato the latter is only "the power which the soul has of recovering, when by itself, some feeling which it experienced when in company with the body." His illustration is that of impressions left in wax.[2]

ARISTOTLE was the first to ask *how* we perceive time.[3] He did not conceive his Kosmos to have had a beginning; all in it is an eternally changing correlation between matter

[1] "Plato and other companions of Sokrates" by George Grote, (London, 1865) III, 248—257, and notes.
[2] Phædo, 73, 74.
[3] Alfred Wm. Benn, "The Greek Philosophers," I, 326. Wilhelm Volkmann, "Lehrbuch der Psych.," I, 37. Edwin Wallace, "Aristotle's Psych.," introduction. Also Grote, Lewes, etc.

and form.[1] "Matter is the original substratum, while form is nothing apart from form."[2] There are all gradations of this correlation, from clay bank to statue, from statue to human soul.[3] Soul ranks with form, not with matter. The matter to which soul stands correlated, is a natural body (*i. e.*, a body having within it an inherent principle of motion and rest) organized in a certain way, or fitted out with certain capacities and preparations to which soul is the active and indispensable complement.[4] The soul is dependent on the body for all its acts and manifestations, and brings to consummation what in the body exists as potential only.[5] . . . We do not say the soul weaves or builds;[6] we say that the animated subject, the aggregate of soul and body, *the man*, weaves or builds. So we ought also to say, not that the soul feels anger, pity, love, hatred, etc., but that the man with his soul does these things. . . . This is true, not only in regard to our passions, emotions, and appetites, but also in regard to our perceptions, phantasms, reminiscences, reasonings, efforts of attention, etc. . . . The actual movement throughout these processes is not in the soul, but in the body . . . They are at once corporal and psychical. . . . Soul is the movent, inasmuch as it *determines* the local displacement, as well as all the active functions of the body—nutrition, growth, generation, sensation, etc.[7] . . . Soul in all its varieties proceeds from the Celestial Body or abode of Divinity.[8] . . . The varieties of soul are distributed into successive stages. . . . The lowest soul is the primary cause of digestion and nutrition; it is cognate with celestial heat.[9] . . . We advance upward now from the nutritive soul to that higher soul, which is at once nutritive and sentient . . . with multiple faculties and functions. . . . Sensible perception with its accompaniments, forms the char-

[1] De Celo, Bk. II, Ch. 1 (Ed. Sprengel); Wallace, op. ct., p. xii.
[2] Metaph. Z, 8, 1033, b. 12 seq.; Θ. 3, 1047 a. 25.
[3] De Anima, II, 2, 414; Physica, II, 2, 194, C 8; Metaph. H 6, 1045, C 18; De Gener. Animal. II, 1, 735 a 9; De Celo, IV, 3, 310, C 14.
[4] De Anima, II, 1 sq.
[5] De Generat. Animal. II, i, p. 731, b. 29.
[6] De Anima I, iv, p. 408, b. 12.
[7] De Anima II, iv, p. 415, b. 1.
[8] See Grote, Ibid. 220.
[9] De Anima II, i, p. 731, b. 33.

is that which gives thereto definite individual being. Matter acteristic privilege of the animal[1] . . . and admits of many diversities from the simplest and rudest tactile sensations . . . to the full five senses.[2] . . . The sentient faculty, even in its latest stage, indicates a remarkable exaltation of the soul in its character of form. . . . The soul, *qua* sentient and percipient, receives the form of the *perception*[3] . . . as wax from a signet.[4] . . . The sentient soul (its 2d stage) requires a cause to stimulate it into actual seeing or hearing, . . . a stimulus from without, from some individual object, tangible, visible or audible; but the noëtic or cognizant soul (3d stage) is put into action by the abstract and universal . . . so that a man can at any time meditate on what he pleases[5] . . . All the objects generating sensible perception are magnitudes.[6]

Some perceptions are peculiar to one sense alone, as color to the eye, etc. There are some perceivables not peculiar to any one sense alone, but appreciable by two or more . . . such are motion, rest, number, figure, magnitude.[7] "But each single sense perceives nothing but one single quality or group of qualities.[8] . . . There is required then some one function of the mind, by means of which it gains perceptions of all objects,[9] . . . some common central organ of perception in which the separate communications of the senses are combined; . . . it must within one and the same moment of time, present before itself two or more reports of sense."[10] . . . This exercise of comparison, which Aristotle thus assigns to the central or the common sense, is not, however, restricted to the work of distinguishing the separate communications of the senses; it displays further its synthetic power in grasping the common properties which are involved in the

[1] De Sensu., i. p. 436, b. 12.
[2] De Anima II, iii, p. 414, b. 2; 415 a. 3; III, i, p. 424, b. 22; xiii, p. 435, b. 15.
[3] Ibid. II, xii, p. 424, a. 32, b. 4.
[4] Ibid. II, xii, p. 424, a. 19.
[5] Ibid. II, v, p. 417, b. 22; III, iii, p. 427, b. 18.
[6] De Sensu., vii, p. 449, a. 20.
[7] Grote's Aristotle II, 186-198; De S. et S. i, p. 437, a. 8; iv, p. 442, p. 4-12.
[8] Psychology iii, 7, p. 431, a. 24.
[9] De S. et S. 7, p. 449, a. 8.
[10] Psy., p. 426, b. 22.

existence of the qualities of the body.[1] For at the same time as we perceive, say color, we perceive it, further, as a colored surface or *magnitude*; at the same time as we have the sensation of notes following on one another, we perceive the fact of *number*; and at the same time again, as we feel a surface hard or soft, we perceive it as some kind of *figure*. Beyond these, the particular objects of the single senses, we require to recognize a number of qualities ("categories") which enter more or less into each of our sensations . . . and which, in Aristotle's words, "we perceive immediately in connection with each perception."[2] Chief of these qualities or "categories" were "*motion*" and "*rest*;" next came "*number*." Finally, for our purpose, Aristotle remarks: "*Time is the number of motion.*"[3] Psychologically considered, then, time *is an immediate* (*central*) *sense-perception of* "*the number of motion.*"

But is not memory requisite for perception of time? We are told "Memory, as well as phantasy (imagination) are continuations, remnants, traces or secondary consequences of the primary movements of sense. Both of them belong to the same psychological department—to the central sentient principle, and not to the cogitant or intelligent *nous*."[4] "In acts of remembrance we have a conception of past time, and we recognize what is now present to our mind, as a copy of what has been formerly present to us either as perception of sense or as actual cognition[5]; while in phantasms there is no conception of past time, nor any similar recognition, nor any necessary reference to our past mental states." "What is remembered is a present phantasm assimilated to an impression of the past."[6] Aristotle draws a marked distinction between the (memorial) retentive and reviving functions, *when working unconsciously and instinctively*, and the same two functions when stimulated and guided by a deliberate purpose of our

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[1] De Anima III, i, p. 425, a. 15.
[2] De S. et S., C. 4, p. 442, b. 4; De A. II, 6, p. 418, a. 17. Wallace's Aristotle, Psych., lxxvi-lxxix.
[3] De Celo, Ch. 9, 8–10.
[4] De Memor. et. Remin. i, p. 451, a. 5; p. 449, a. 10.
[5] Ibid. i, p. 449, b. 22.
[6] Ibid., p. 450, a. 30; 451, a. 15; De Memor., p. 240.

own, which last he calls reminiscence. He considers memory as a movement proceeding from the centre (heart) and organs of sense to the soul, and stamping an impression thereupon; while reminiscence is a counter-movement proceeding from the soul to the organs of sense."[1-2-3]

On occasion, however, he used time both to denote an objective and a subjective concept. "Both motion and time are thus eternal, both are also continuous; *for either the two are identical*, or time is an affection (πάθος) of motion."[4]

Thus in brief, time-perception with Aristotle was a direct sense-perception — the immediate function of the sentient faculty or soul; this, whether under the presentation of primary sensation or of memory. We have given much space to this remarkable first exposition of time because it is most important historically, and in its essential features it has survived in all ages, and is even now the accepted theory of prominent psychologists.

Post-Aristotelian and Mediæval discussions of "the faculties" are important, in so far as they lead to later theories. The doctrine of soul faculties is so old that Diogenes Laertius cites Pythagoras as its source. After Aristotle, the Stoics found difficulty in agreeing upon the number of the faculties, and in reconciling any plurality of them with the unity of the soul. To these perplexities the Neo-Platonists joined that of the self-consciousness of the soul. Philo compared the relation of the soul to the faculties to that of the house to its tenants. The Patristic authorities insisted on the strict unity of the soul. Tertullian substituted the term "soul-faculties" for the older term "soul parts" or "soul divisions," and compared the soul to the wind which blows the pipes of an organ; the pipes representing the faculties. Gregory of Nazianz revived the simile of Plato, that the

[1] De Anima I, iv, p. 408, b. 17; De Memor. i, p. 450, a. 30; ii, p. 453, a. 10.

[2] Grote. op. cit. II, 212–215.

[3] Memory "is the permanent possession of a sensuous picture, as a copy which represents the object of which it is the picture." De Memor. I, p. 451, a. 15. He adds that memory is the function of our ultimate faculty of sense which "is also that by which we gain a consciousness of time." Ibid., p. 450, a. 12.

[4] Metaph. Λ, p. 1071, b. 15.

soul was the driver of the wagon; and the faculties were the horses. St. Augustine developed advanced ideas of memory, but with the revival of Aristotle among the Scholastics, "the faculties" again rose almost to supreme discussion; all deemed themselves bound to maintain the unity of the soul. The view of Thomas Aquinas was that most commonly held, *i. e.*, "the faculties, from the essence of the soul, *sicut a principio fluunt.*"[1] Roger Bacon contended for the *sensus communis* of Aristotle, whose philosophy in general he accepted.[2] With Wm. of Occam, all thoughts are "conditions of the soul."[3] During the Reformation, the orthodox doctrine was defended by Suarez, while Melanchthon held nearly to the teachings of Aristotle. Thus the opposing views of "unity" vs. "faculties" occupied the field, at the date of Descartes, Hobbes, and Leibnitz.

RENÈ DESCARTES followed the orthodox schoolmen as against Aristotle in considering the soul as one indivisible "thinking substance;" its diverse "faculties" are but different *modes* of the one "*facultas cognoscitiva*" — the "thinking soul."[4] Aristotle at least caught sight of the mystery of our perceiving at the single moment that *is*, the 'fore and aftness' of a series which *has past*, and he conceived apparatus and processes to account therefor. Descartes, with naïveté, looked on such mental acts as direct and indissoluble "modes," or "conditions," of the "thinking soul."[5] In this conception is the foundation of his philosophy; the soul sees directly; ideas are intuitions, "the innate power of thought itself;" "they are in the mind, and when exercised, are perceived to have been there before."[6] Certain of these innate concepts lie at the foundation of all the rest; without them no

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[1] For full references for above see Volkmann's Psychologie (1885), I, 22, sq.
[2] Erdmann's Hist. Philos., I, 478-481.
[3] Ibid., 504.
[4] Pass. de l'âme I, 47 sq.; Med. end of II, IV; VI, 77, etc.; Prin. d. Philos. I, LIII; Kuno Fischer—Descartes and his School—Tr. Gordy, p. 419.
[5] Letter to Vatier, Nov. 17th, 1643; Ed. Elz. 1, Ep. 116; Ibid., Ep. 105; Princ. i, § 57-59; Med. III.
[6] Règ. iii, p. 211-214; V, 225; Med. V, 64; Erdmann's Hist. Philos., Hough, Tr. II, 26.

kind of conception of anything is possible. *Space and time are such direct, innate, and fundamental concepts.*

Descartes makes one advance upon Aristotle, in specially distinguishing duration from the "numbering of motion." "We shall also have most distinct conceptions of duration, order, and number, if in place of mixing up with our notions of them, that which properly belongs to the concept of substance, we merely think that the duration of a thing is a mode under which we conceive this thing in so far as it continues to exist;"[1] "for we do not indeed conceive the duration of things that are moved, to be different from the duration of things that are not moved."[2]

Descartes distinguished two kinds of thought—"active" and "passive;" the active are the "different modes of willing;" the "passive" include time-perceptions. Yet time was not with Descartes a *sense* perception as with Aristotle; *his time-perceptions spring innately "from the intellect" or soul "alone."*[3]

Yet Descartes' physiology is not always easily harmonized with his philosophy, nor his mechanical explanations of memory with *entirely* innate intuitions of time. He says "Recollections are traces of images on the brain" — "traces of previous movements left in the brain like folds in paper;" the movements of the vital spirits through these traces "become for the soul, occasion and opportunity for calling forth ideas which resemble them."[4] "By memory, we connect present and past." "When I think of myself as now existing, and recollect besides that I existed some time ago, and when I am conscious of various thoughts, whose number I know, I then acquire the ideas of duration and number, which I can afterwards transfer to as many objects as I please."[5] Descartes tells us "the movements of the brain affect the soul or mind."[6] "Perception is impossible without

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[1] Prin. d. Phil., I, LV, 137.
[2] Ibid., I, LVII, (Tr. Ed. Edinburgh, 1873.)
[3] Ibid., I, XXXII; Med., II, etc.
[4] Notæ ad. progr. quodd., p. 185–188; Erdmann op. ct. II, 28.
[5] Med. VI, 88; III, 45.
[6] Prin. d. Philo. I, XLVIII, 170.

the body."[1] "From the motion of the body alone, can the various sensations be excited."[2] "The soul perceives only in so far as it is in the brain."[3] Yet he as distinctly says "by the omnipotence of God, the mind can exist without the body,"[4] and one of his commentators says "according to the fundamental principles of his philosophy, mind, on account of its absolute diversity from body, is supposed to hold no immediate converse with matter, but only to be cognizant of it by means of its own modifications, determined hyperphysically on occasion of certain affections of the body with which it is conjoined."[5] Kuno Fischer shows that it was these uncertainties or contradictions of Descartes, which led in opposing directions to the occasionalism of Geulinx, the systems of Malebranche, of Spinoza and of Leibnitz."

THOMAS HOBBES declared that the soul is known only through faith, and is not a subject of philosophy; he was the first to confine his speculations to "mental facts," avoiding cognative "faculties;" though he did at times "see the need of some other sense to take note of sense by," he yet presaged so much that is explanatory in the unfathomed *processes* of thought, as bravely to declare "that all that is wanted to account for such introspective consciousness could be found in memory."[6] He says all sense and all thought are "subjective;" are "something that lies entirely in us;" "yet is as mechanical as nature." "According to a universally valid law of nature, the affections of the sense organ, when the impression has ceased, must continue, and this echo of the impression is called memory, thought, or imagination. It is so inseparable from the sensation that it may be compared to a sixth sense accompanying the rest. . . . *Like water troubled, an organ of sense will remain in motion.* . . . *In that case the corresponding phantasm is called imagination; or memory, if regard is had to the fact of the lapse of time, which like distance in space, is found to render the phan-*

[1] Med. II, 27.
[2] P. d. P. IV, CXCVII.
[3] Ibid. IV, CXCVI.
[4] Reply to the several objections—Prop. 14, (Tr. Edinburgh, 1873.)
[5] Ibid. Note, p. 200; where see several references.
[6] "Hobbes" by George Croom Robertson (1886), p. 124.

tasms of sense both less clear as wholes, and less distinct in parts."[1]

In his De Corpore, Hobbes devotes Chapter VII to space and time. "All body . . . exists with one constant attribute of extension mentally represented as space; and all its variable and varying aspects explicable in terms of motion, are mentally represented in time." Time is "a phantasm produced by body in motion;" it is "simply the idea of motion, or of moved body." Yet he adds that time "*stands rather for the fact of succession or before and after in motion.*"

As far as I know, the word "succession" or any exact equivalent, here enters the discussion for the first time. "The comparison or assimilation of sense impressions into time percepts gets little further attention from Hobbes, though he notes in one place its ground-form, the recognition of identical experiences had at different times."[2] Hobbes is the Father of the English School of Association.[3] His importance in the history of the problem of time rests on his being the first of moderns to plant himself on this doctrine, namely: "There is no conception in a man's mind that hath not at first totally or by parts, been begotten upon the organs of sense. The rest are derived from that original."[4]

With SPINOZA time was a mode of his all-embracing substance.

JOHN LOCKE believed in an immaterial soul that thinks.[5] Its faculties are not "separate agents," but "different ways" or "powers" of thinking; the first "power" is to perceive.[6] There are two sources of ideas: First, sensation, and, second, "perception of the operations of our mind within us," which he calls "reflection."[7] "Which operations, when the soul comes to reflect on and consider, do furnish the understanding with another set of ideas, which could not be had from things

[1] Human Nature, C. 3. Also he speaks of memory as "decay of sense;" *i. e.*, fading.
[2] Robertson, op. ct. 127.
[3] Lewes Hist. Phil., p. 232; Sir Wm. Hamilton in "Reid's Works," p. 898.
[4] Leviathan, C. i. See Robertson, op. ct., p. 84.
[5] Essay Concerning Human Understanding; Bk. II, Ch. xxiii, Sec. 22.
[6] Ibid. vi, 2; ix, 1.
[7] i, 3 and 4.

without; and such are perception, thinking, doubting, believing, reasoning, knowing, willing, and all the different actings of our mind; which we, being conscious of and observing in ourselves, do from these receive into our understanding as distinct ideas as we do from bodies affecting our senses. This source of ideas every man has wholly in himself."[1] One of the fundamental acts or powers of mind is that of "*bringing two ideas, whether simple or complex, together, and setting them by one another so as to take a view of them at once . . . by which it gets all its ideas of relations.*"[2] He devotes more than one chapter to "*relations,*" *which, I believe, though destined to an important place, are here, for the first time, brought onto the psychological field, as separate mental elements*—surely the mark of an epoch, good or bad. Locke tells us that relations "consist in the consideration and comparing one idea with another."[3] Had he been asked what "considering and comparing" were, he probably would have said, "the act of perceiving relations." He says "the ideas of relations are often clearer than the subjects related."[4] He devotes a good share of his work to proving, against Descartes, that ideas are never *innate*, yet it is fundamental with his own system that these "relations" are perceived *intuitively*. With simple relations, "the mind is at no pains of proving or examining, but perceives the truth, as the eye doth light, only by being directed toward it. Thus the mind perceives that white is not black; that a circle is not a triangle; that three are more than two, etc."[5] "In every step reason makes . . . there is (and must be) an intuitive knowledge."[6]

Locke classifies time-perception as partly sensation and partly reflection. He sums up his chapter on our subject with six propositions: "(1) By observing what passes in our minds, how our ideas there in train, constantly some vanish and others begin to appear, we come by the idea of succession.

[1] I, 3 and 4.
[2] XII, 1.
[3] XII, 7.
[4] XXV, 8.
[5] IV, II, 1.
[6] IV, II, 7.

(2) By observing a distance in the parts of this succession, we get the idea of duration. (3) By sensation observing certain appearances, at certain regular and seeming equidistant periods, we get the ideas of certain lengths or measures of duration as minutes, hours, days, years, etc. (4) By being able to repeat these measures of time, or ideas of stated length of duration in our minds, as often as we will, we can come to imagine duration where nothing does really endure or exist; and thus we imagine to-morrow, next year, or seven years hence. (5) By being able to repeat ideas of any length of time, as of a minute, a year, an age, as often as we will in our thoughts, and adding them one to another, without ever coming to the end of such addition any nearer than we can come to the end of number, to which we can always add, we come by the idea of eternity, etc. . . . (6) By considering any part of infinite duration, as set out by periodical measures, we come by the idea of what we call time in general." He says "by reflection, we perceive directly and intuitively the time-relation between these ideas."[1] "Most of the denominations of things received from time are only relations."[2] . . . "When one fixes his thoughts intently on one thing . . . he lets slip out of his account a good part of that duration, and thinks that time short." He denies, as against Aristotle, that we get our idea of succession from motion.[3] If motions are too slow, he says, we do not perceive their succession; if too fast, neither their duration or succession. The following presages psycho-physics: "Our train of ideas, when awake, probably succeed one another, in our mind at certain distances, not much unlike the images of a lantern turned round by the heat of the candle. This appearance of theirs in train, though perhaps it be sometimes faster and sometimes slower, yet I guess varies not very much in a waking man; *so has a certain degree of quickness*, with bounds beyond which it can neither delay or hasten. . . . *So that* to me it seems that the constant and regular succession of

[1] "Whenever the memory brings any idea into actual view, it is with a consciousness that it had been there before, and was not wholly a stranger to the mind." I, iv, 20.
[2] II, xxvi, 3.
[3] II, xiv, 6.

ideas in a waking man is, as it were, the measure and standard of all other successions."[1] He says "no two parts of duration can be certainly known to be equal." . . . "Time is not the measure of motion," but space *and* time . . . "time is to duration what place is to expansion."[2] In a word, time with Locke was an intuitive perception of relation between successive durative ideas; his discussions show much advance in our subject.

LEIBNITZ conceived the universe to comprise an infinite number of individual soul-units or monads, without causal relations to each other; by pre-established harmony each monad developed within itself a psychic life, "mirroring" or corresponding to the world within a certain scope around it.[3] Faculties, he declared, "were but fictions." The soul did not think, feel and perceive; but thought, feeling, perception, *were* the soul itself under different forms of activity. Time was one of these forms.[4] All thoughts were innate; "the mind itself is innate;" "all soul life develops from within itself."[5] Time, therefore, is innate, and but a "phenomenon" of soul development.[6] Leibnitz can with more consistency than Descartes declare ideas to be innate, as in his system *each* of his monads mirrors every event in the entire universe. Each is *unconscious* of all below a certain stage; thus all sensations and ideas are in the mind from the beginning, but rise to consciousness only when apperceived.[7] Characteristically of his system, he says space and time "express possibilities;" "they are of the nature of eternal truths, which relate equally to the possible and to the existing;" they determine existence in some of its relations, and as such are logically prior to any given form of existence. "Time (not duration) exists only as events are occurring, and is the relation of their succession." Time is purely rela-

[1] II, xiv, 8–12.
[2] II, xv, 5.
[3] Monadologie, p. 709, sq.
[4] De phen. real. p. 444; à Bayle, p. 159.
[5] Prin. d. l. Nat., p. 714.
[6] Compare Noveaux Essais, LIV, ii, Ch. i; 1, IV, i; à. Bayle, p. 159; à. Clarke.
[7] à. Borguet, p. 720; à. Bayle, p. 187; Monadologie, p. 706; System Noveau, p. 127; Prin. d. l. Nat., p. 715; ad. Des Bosses, p. 740.

tive and ideal;[1] a relation, he says, cannot be in the thing which it relates; "can not have one leg in one object, and the other leg in the other." The relation exists alone in the mind; yet, if all objects and events were annihilated, time and space would still have their ideal existence in the intelligence of God as the eternal conditions of all phenomena. Leibnitz gives us few psychological details of time; he included all vaguely under his *Vorstellungskraft*. He was perhaps the first of moderns to emphasize some requirement for "joining the manifold in one."[2]

CHRISTIAN WOLFF clarified the ideas of Leibnitz with greater influence upon German psychology in general than on our particular subject.[3]

SIR ISAAC NEWTON[4] and SAMUEL CLARKE (the latter by controversies with Leibnitz[5]) focused to clearer definition the thought of their day regarding space and time.

GEORGE BERKELEY instituted one of the greatest epochs in psychology by first disclosing the complex make-up of seemingly elemental sensations, but gave attention to space rather than time. "When abstracted from the succession of ideas in our mind, I can form no idea of time at all; it is nothing."[6] He looked upon time perception as an act of reason rather than of sense. "Sense supplies images to memory; these become subjects for fancy to work upon. Reason considers and judges of the imaginations." "Number is no object of sense." "The mind so far forth as sensitive, knoweth nothing."[7] "There is that in us not given by sense, though it is only in a latent state." Yet with Berkeley ideas were not innate preconditions as with Descartes; all thoughts are the direct gift of God; for as processes and laws they fall directly from His will.[8]

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[1] Opera Philos., p. 682, 752.
[2] Ep. III, ad. Des Bosses, op. Phil., 438.
[3] His chief departure from Leibnitz is that he denied that *all* monads are perceptive.
[4] Newton thought the omnipresent existence of the Deity constituted space and time. Principia, Ch. 1.
[5] Complete Works, London, 1732–42.
[6] Prin. of Human Knowl., § 99.
[7] Ibid. XXV; Siris § 288, 305.
[8] See Campbell Frazer's Berkeley, Phila., 1881.

DAVID HUME was critical rather than constructive. From Aristotle, we have seen the requirement for some "faculty" to join the manifold of mind steadily forcing itself upon consideration. Hume stripped the problem of vagueness. After reducing mind to a succession of impressions, ideas, and relations, he declares at the end of his treatise: "All my hopes vanish when I come to explain the principles which unite our successive perceptions in our thought or consciousness. . . . In short, there are two principles which I can not render consistent, nor is it in my power to renounce either of them, viz., that *all our distinct perceptions are distinct experiences*, and that *the mind never perceives any real connection among distinct existences*. Did our perceptions either inhere in something simple or individual, or did the mind perceive some real connection among them, there would be no difficulty in the case."[1] Here is the essence of our time-problem set forth for the first time with isolated explicitness, if yet imperfectly. It is perhaps the clearest proof of Hume's greatness, that, seeing the difficulty, and not seeing the answer, he refrained from a "system."

Following Locke, Hume recognized "perceptions of relation" to be the "essence of cognition."[2] Perception of time-relations, thus became an act of reason—something more than sense. All reasoning "consists in nothing but comparison and discovery of the relations, either constant or inconstant, which objects bear to each other."[3] Yet all he can explain of relation is, "that quality by which two ideas are connected."[4]

With Hume, "the ideas of space and time are *copies of impressions perceived in a particular manner*. The idea of necessary connection is merely the reproduction of an impression which the mind *feels* compelled to conceive in a particular manner." Our idea of time "is derived from the succession of our perceptions of every kind."[5] "All impressions

[1] Works (ed. 1854), ii, 551; Hume says it will ever be impossible to decide as to the origin of impressions—p. 113.
[2] Ency. Brit.
[3] Ibid. i, 100.
[4] Ibid. i, 29.
[5] Ibid., p. 54. Hume thinks that the idea of duration is derived from succession of change. "We associate the continual successions of our mind with steadfast objects; this gives us the idea of their (the steadfast objects) duration; without this associate succession, they would not appear in time." pp. 90, 57.

and all ideas are received or *form part of a mental experience only when received in a certain order — the order of succession.*" Yet he distinctly declares that "*Time is not a particular impression* . . . it rises from the manner of the succession of the impressions, *yet without making one of the number.*" "Five notes, played on a flute, give us the impression and the idea of time, though time be not a sixth impression, which presents itself to the hearing or any other of the senses. Nor can the mind by revolving over a thousand times all its ideas of sensation, ever extract from them any new original idea, *unless nature has so framed its faculties*, that it *feels some new original impression* arise from such a contemplation. But here it only takes notice of the *manner* in which the different sounds make their appearance, and *that* (the manner) it may afterwards consider, without considering the particular sounds, but may conjoin it (the consideration of the manner) with any other objects. The ideas of some objects it certainly must have, nor is it possible without these ideas, ever to arive at any conception of time, which since it appears not as any primary distinct impression, *can plainly be nothing but different ideas, or impressions, or objects, disposed in a certain manner, that is, succeeding each other.*"[1] It is difficult to reconcile Hume's above "*ideas* of time *derived* from succession," with his declaration that it "*can plainly be nothing but different ideas* . . . *succeeding each other.*" He did not quite arrive at the great question whether the *idea* of time is "nothing but ideas succeeding each other," yet no one has more lucidly cleared his mind to what time-perceptions are not. He was hampered by traditions of "relations," and that all ideas must be "unit representations" and "individual pictures;" yet he continually struggled toward the thought that time-perception should be explained by succession alone. One strangely isolated declaration markedly indicates his genius and the drift of his mind from his traditions. He says in his chapter on Ancient Philosophy: "The imagination readily takes one idea from another . . . is carried from one part of it (the succession) by an easy transition . . . *This easy transition is the*

[1] Ibid., p. 56.

effect or rather the essence of relation."

HARTLEY first sought to carry back much of psychology to physiology,[1] yet conceived memory and time-perception to be fundamental acts of mind.

CONDILLAC, abandoning Locke, declared "all our knowledge and all our faculties to be derived from sensations."[2] A sensation, which "preserves its vivacity," becomes attention. "If a sensation acquire greater vivacity than the former, it will become in its turn attention. . . . Our capacity of sensation, therefore, is divided into the sensation we have had, and the sensation we now have; we perceive them both at once, but we perceive them differently; the one seems as past, the other as present. The name of *sensation* designates the impression actually made upon our senses (present); and it takes that of *memory* when it presents itself to us as a sensation which has formerly been felt (past). Memory is only the transformed sensation. When there is double attention (to present sensation and past memory) there is comparison; for to be attentive to two ideas, and to compare them, are the same thing. But we can not compare them without perceiving some difference or some resemblance between them; to perceive such relations is *to judge*. The acts of comparing and judging, therefore, are only attention; it is thus that sensation becomes successively, attention, comparison, judgment. . . . . Numbering, imagining, wondering, having abstract ideas, *having ideas of time* and number, knowing general and particular truths, are only different ways of attending;"[3] *i. e.*, are but different successive combinations of sensation.

Thus by Condillac, for the first time in history, is absolutely the whole of mind conceived to be but different successive combinations, derived from a like source and of essentially like nature; the insufficient praise, which is bestowed upon Condillac for this position, is indicative of even a present lack of appreciation of its pre-eminent truth and importance; a truth toward which all modern psychology seems gradually tending.

It is just to PETER BROWN, Bishop of Cork, to note that he

[1] See his Theory of Vibratiuncles.
[2] Traité d. Sensations, p. 1 sq. For condensed exposition see first chapters of his Logique.
[3] Ibid.

had, perhaps, previously arrived at a similar conception, though indefinitely. Condillac preserved his belief in the soul as an entity; his follower, DE TRACY, abandoned such, while CABANIS and HELVETIUS avoided the question. Cabanis, for the French, inaugurated the epoch of considering psychology as entirely dependent on physiology. That part of his work, which has most bearing upon the matter in hand, is his physiological differentiation of internal from external sense. HELVETIUS' views are practically those of Condillac[1]. FRANCESCO MARIA ZANNOTTI, an Italian disciple of Hartley, held developed conceptions of time-associations.[2]

IMMANUEL KANT took up the problems stated by Hume; these were the mysteries of Mental Veracity and of the Unity of Diversities. For the solution of these questions Kant started with traditional belief in the dualistic entities, souls and things-in-themselves.[3] His day had not outgrown the error of conceiving the soul or mind to be the direct, active, and sole *organ* of thought; according to this view, things are known and seen immediately; the bodily organism is looked upon as a mere spy-glass, or rather, is practically neglected altogether. To Kant's clear mind, the first essence of ultimate material entity was plainly, in the light of the discussions of his day, immunity from change;[4] inasmuch, therefore, as to him, there was nothing but souls and things, since change could not happen to things, there was no alternative, but that such must be an effect or characteristic of mind.[5] This, then, is the first fundamental thought of, and key to, Kant: *The cause of all change lies in the mind.* But mental change means mental diversity; and having started with the unity of the soul, Kant was compelled to look upon mental Unity of Diversity as an ultimately insoluble mystery. Now comes the supreme merit of Kant, in that he inserted a clear wedge of distinction between the *causative* and the *caused* within the mind. He saw that diversity was a characteristic of the product or content of mind, while unity was characteristic of the way this

[1] See his De l'Homme, Vol. I, c. iv; De l'Esprit, Ch. 1.
[2] Della forza attrativa delle Idei, (1747 (?) to 1790).
[3] Critique, 2d Ed.; Meiklejohn's Tr.; pp. 22, 45, 104, 167, etc.
[4] Ibid. 29, 136, etc.
[5] Ibid. 25, 29. To Kant our bodily organism was but more "things."

content was held or bound together within or by the soul; Close at hand follows Kant's great demerit and confusion. While he is clear and consistent throughout in distinguishing the diverse content from the unitary form, he is neither clear nor consistent anywhere, in distinguishing between unitary form as *cause*, and as some sort of conscious *result*—self-conscious, even though he might conceive that result to be, in delusive distinction from other mental content or result.

Time with Kant is an *à priori* form of mind (p. 22). But confusion and contradiction is betrayed in this phrase from the outset; does he mean mind as *cause?* or mind as *result*, as *content?* Surely a result, a content, never is *till* it is, therefore the term *à priori* is never in any way applicable to it; yet we shall find Kant continually speaking of time as an *à priori intuition*, and classifying intuitions as *content* of mind.

This confusion is vital to Kant's philosophy; to understand it we must discover its origin. It will be noted that he first investigates space, and most profoundly; then he places time on precisely the same basis as space, as a "form of thought." Now when we consider sight, and remember that Kant was little, if at all, familiar with post-Berkeleyan psychology which splits up space-perception into disparate elements, we easily discover how he became impressed with the apparent unity of the visual field, in contradistinction to its diverse objective content; here "nothing objective is added to the field, when two objects appear *beside* each other;" this apparent "besideness" is nothing added to the objects, or to their objectivity, or to the objectivity of the whole field; it is, so it appeared to Kant, something apart from objectivity, from sense; he called it an "intuition." These objects are not *thought* beside each other; they merely *are* in that mental aspect. In this way space, in the abstract, appeared to him something apart from objectivity; Kant identified besideness with space, the apparent unity of abstract space with the apparent unity of the visual field; he assumed that the ultimate cause of both lay in the unity of the soul. Conceiving both to be attributes of mind, in order to designate "the field" from its objects, and space from its make-up content, he

called the one "matter," the other "form." Falling in with the confusion of ages, in using mind indifferently as an equivalent both of soul and of consciousness—that is, as *cause* and as *result*, it was easy for him to fall into like confusion as to *forms* of mind, and as to space and time as such forms; and finally he accustomed himself to declare that space and time are *à priori intuitions*[1], though evidently he never intended to mean that intuitions as present mental *results* were *à priori*.

It remains to discover how he came to put time upon the same basis as space as an *à priori* form or intuition. This appears to have come about entirely through careless susceptibility to analogy. Having worked out his problem with reference to the above and below of spatial diversities, it was easy to conceive that the same formula explained the fore and aftness of temporal diversities; here was change, and again "nothing objective added," yet mental perspective and intuition of relation; once more, according to his fundamental proposition, all cause of change can alone lie in the mind (soul); here, then, is but another *à priori* form of mind, needing nor permitting further analysis. The crucial error of Kant lay in not perceiving that the "unity of diversity" problem, and the "unity of space" problem, were, at the same time, time problems. Take away the co-existence of the diversity and there is no unity of diversity—these same diversities could then succeed each other in as many individual minds, as well as in an individual mind; we are then compelled to investigate whether mere succession in an individual mind may be conceived to yield perceptions of time relations or not. Our present purpose is in no way critical; we only wish to make plain that Kant did hold that the simplest possible succession in our mind was accompanied necessarily with some sort of intuition of fore and aftness, and to show how he came to this belief. The latter I have sufficiently indicated; it remains to give clear evidence of the extent of his theory. Too frequently to be mistaken, he makes explicit his position as follows: "Time is a necessary representation lying at the foundation of all intuitions. With regard to phenomena in general, we can not think away time from them" (p. 28). "It is the subjective

[1] Chapter on Time, p. 28; p. 22, 30 § 7.

condition under which all our intuitions take place" (p. 30). "Time is the formal condition *à priori* of all phenomena whatsoever" (p. 30). "All phenomena in general, that is, all objects of the senses, [not things, but all their objective representations], are in time, and stand necessarily in relations of time" (p. 31). Hume's notes, therefore, according to Kant, carry with their occurrence some sort of intuition, or awareness of their succession, and of their time-relation. There is, we think, abundant evidence for this interpretation and none whatever against it. It is in harmony with his system of philosophy as a whole. His declarations of it are explicit and comparatively numberless. The genetic progress of his Critique shows how he arrived at this view. His whole future *à priori* handling of the categories and of the synthetic activities of the understanding conforms to and supports it. It is upon precisely this conception that Kant, from the first, makes his main and fundamental division of the mental faculties; drawing a sharp line between two chief faculties, the one passively receptive, the other active or spontaneous, he classifies intuitions entirely among the former; to the latter belong all acts of the understanding.[1] There can be no doubt that any such complicated act as memory, used in the English school sense of the term and involving recognition of *having been before*, etc., would have been classed other than as passive intuition; *i. e.*, than as he did classify time-intuition; yet excluding recognition or memory proper from reproduction, we have Kant's imagination; which, in so far as intuition of sequence or fore and aftness may be concerned, he placed undoubtedly upon identically the same footing as original sensations themselves.[2] There should be no reasonable doubt, therefore, by any school, that Kant's real position as to the time problem was that all mental series whatever, however

[1] pp. 18, 21, 45, etc. No metaphysician excels Kant in precision in defining his faculties. We have *Vorstellen*, representation; *Wahrnehmen*, perception; *Kennen*, knowing; *Erkennen*, cognizing; *Verstanden*, understanding; *Einsehen*, perspecting; *Begreifen*, comprehending. See appendix, Tr. Critique, London, 1838. An intuition with Kant was not even a perception, because not conceived as implicating self-consciousness, p. 86. Much less did time intuition include the English act of memory.

[2] No student of Kant will declare that he conceived memory *necessary* to an intuition of time.

simple, or whether original sensation, or reproductions thereof, were necessarily and invariably accompanied by some vague awareness or intuition of their successiveness—their time order, and that the cause of this fact lay *à priori* in the soul; that the tying or joining lay altogether below the surface of consciousness in the substance of mind. It will be observed that in proportion as this conception expands in the mind and is extended over the whole range of associated reproductions, the less demand is there for any further explanation of memory; in fact, strictly speaking, this view does not require any further explanation for memory, and, as a final confirmation of the interpretation of Kant, which I have given, I would call attention to one of the most unique facts in all literature, (one I have nowhere seen mentioned), namely, that in Kant's Critique of Pure Reason, in which time-intuition plays such a preponderating part, both fundamentally to the system, and also in the page-surface of the book *the subject of memory is not once referred to, nor even the word memory or its equivalent once used, not even incidentally throughout.* This—unless in some obscure place, it has escaped my special search for it, line by line, from cover to cover. Nothing could more conspicuously emphasize Kant's preternatural genius for following out precisely and consistently any principle, right or wrong, once believed to be determined. Kant's entire system is built up on the *à priori*; and when we come to think of it, *à priori memory* would have contradiction in the very sound of it; and Kant, with instinctive and colossal consistency, actually builds up his system of mind utterly without memory.

Kant nowhere approaches discussion of particular time relations, or of how any one relation is intuited rather than another, and this is the whole problem. He tells us "time ever flows;" he does not make plain to us how his *à priori* conditions of the mind ever flow, and continually so adjust themselves that an event happening yesterday will inevitably be intuited by us to-day *as* yesterday, and a year from to-day be intuited by us as last year. Of one of a series of five notes,

[1] We do not intend to say he does not treat of memory in any of his works; he does so in the Anthropology.

say the fourth, it would be interesting to know what particular time order Kant would have conceived it *necessarily* to appear in; would it be as after the second, or as after the first, or only as after the third? or again perhaps would it be before the fifth? or if related to any event in particular, why not to one of last week, or to the last century, or to all events all together?

Thus it must be seen that Kant's own conception of an "intuition" of time, at best could have been but a vague awareness of succession in general or in the abstract,[1] and the close student of the time problem must judge for himself what that could really mean or how much he has gained by this, or by being told by Kant that time is an *à priori* form of mind.

MARCUS HERTZ[2] and other followers of Kant, wrote in explanation of his views of space and time which were adversely criticised, and particularly by ADAM WEISHAUPT.[3] JACOBI in defending empiricism, denied the *à priori* space and time; so also HERDER. SCHLEIERMACHER held space and time to be both forms of intuition and forms of objective things.

REINHOLD followed Kant in essentials, but turned the current of Germany toward "a single faculty." Perceiving Kant's confusion of causative form, with formed content, he confines his definition of time to the latter, but includes therein, as did Schleiermacher, both the matter and the form of the content. Yet this more objective ever-present time and space, which he calls "mere time" and "mere space," he insists is not empty time and space. What it is, as "ground form of all receptivity," he does not make quite clear. His struggle for more precise definition than his master, only brings more plainly to view the inherent vagueness of Kant's theory[4].

SCHULZE (Ænesidemus) and SOLOMON MAIMON threw over Kant's *Ding-an-sich*, and set the stream toward idealism. Still struggling with the "Unity of Diversity," they

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[1] p. 147.

[2] "Reflections in Speculative Philosophy." (Königsberg, 1771).

[3] "Zweifel über die Kant'schen Begriffe von Zeit u. Raum" 1787. The author has not been able to procure the above two works, and is unable to speak of them except at second-hand.

[4] "Versuch einer neuen Theorie." Buch III, S. 378–421.

reversed the usual deduction of time from the manifold—from "number of motion," and declared "Without space and time nothing would be discriminated, or separate in consciousness."[1] With them, time was as well a concept as an intuition.[2]

BECK has kinship with Jacobi and Reinhold, but particularly he influenced Fichte. It was Beck who introduced "*the mental act*" into philosophy; no phrase was ever more pregnant of systems. What this "mental act" is, other than the coming and going of mental content, I do not find them to have made comprehensible. A self-consciousness of the act is of course supposed to be involved. With Beck space and time are *Acts* of Synthesis; not Intuition, etc., but Intuiting, Representing, Perceiving. Before the synthesis space and time are not; they are generated in the act. Consciousness resulting from the synthetical act is "pure intuition." Continuation of the synthesis of space results in sequence. Synthesis of sequence is time. The act of synthesis must have a product; *i. e.* the spatial figure or the time must be fixed; this "fixing" of the product gives definite particular figures or times.[3]

FICHTE aspires to tell us the Why and the How, causative of mental life; to disclose that which Kant assumed as a beginning. He admits that his first step is purely an assumption, and that the consequences that can be made to result therefrom are the only warrant therefor.[5] He assumes the mental act of Beck,[6] then declares that every mental act presupposes a power or force.[7] (Why more than it presupposes a thing forceful or a soul mindful?) Thus he transposes every mental fact into a mental act, and finds for each act a

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[1] Maimon's, Versuch über d. Transcendental Philos. S. 16–18.
[2] Ibid. S. 33, 36, etc.
[3] Einzig möglicher Standpunkt u. f. t. Abschn. II. § 3, § 141–167; Grundriss d. Kritischen Philos. I, § 10, 11. 12, 13.
[4] Samm. Werke (Berlin 1845), "Ueber d. Begriffe d. Wis. 1794," I, 70; "Fichte's Science of Knowledge," Tr. by Kroeger (London,1889), p. 49; Werke, "Grundriss," I, 411.
[5] "Begriffe, 1794," I, 58 sq.; 74; "Grundlage, 1794," 92, 101, 226, etc. Tr. p. 34 sq., 54, 64, 75, 185.
[6] "Grundriss," I, 333 sq.; Tr. p. 192; "Begriffe, 1794," I, 63, 70, etc.; Tr. p. 40, 49, etc.
[7] Grundriss I, 372; Tr. 221.

power; whereupon, strangely enough, he is able to reveal to us the truth that these powers so comport themselves as to produce and explain every possible mental phenomenon, thus entirely warranting and confirming his prime assumption. For example, a red spot appears to us spatially to exclude a blue spot: Fichte tells us that a red spot is a "deed-act," the blue spot another "deed-act," that all "deed-acts" mutually exclude each other, and *therefore it is* that red spots appear to exclude blue spots. Of course the value of such a system as this must depend somewhat upon the maker's preliminary interpretations of psychological facts; so long as psychology remains undetermined, or uncertain, the most that can be said for such a system would seem to be that "if things work in this kind of way, why! then this is the kind of way that things work."

According to Fichte, space deed-acts exclude or condition each other co-existingly above, below, etc. Time deed-acts condition each other in the order of a series, that is: Of a series A, B, C, D; C conditions D; B conditions C; A conditions B; A is unconditioned of B, C, or D; B is unconditioned of C or D; C of D. Thus conditioned we *must* think them in the order of their series.[2]

Fichte adds the weight of his opinion to the theory that "There is for us no *past*, except in so far as it is thought in the present . . . Whatsoever was yesterday *is not;* it *is* only in so far as I think in the present moment *that it was.* . . . Of course a time is past, if you posit one as past; and if you ask that question (is it past?) you do posit a past time; if you do not posit it you will not ask that question, and then no time has past for you."[3] Thus time with Fichte is a present thought.

SCHELLING characteristically defines time as "The I itself thought in activity."[4] Erdmann finds Schelling's deductions of space and time "most interesting" in connection with the

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[1] Grundriss 391–405; Tr. 235–249. Also, see Kuno Fischer, Geschichte d. n. Phil., V, 476, u. s. f.
[2] Grundriss 405–411; Tr. 249–255; Kuno Fischer, V, 476.
[3] Grundriss 409; Tr. 253.
[4] Tr. Idealism. Ep. II; D, III, S. 467.

"distinction of outer and inner sense in consciousness;" also, his combination of space and time with the categories.[1]

HEGEL devotes §§ 257–260 of his Philosophy of Nature to time, and treats the subject less particularly in various places. Translated into ordinary language, § 257 tells us that time involves existence or being; § 258 that it involves ceasing to exist, and coming into existence, *i. e.* change and "becoming." Then follow discussions of duration and eternity. No man will more rightly appreciate Hegel than the psychologist who sits down to discover precisely what the "Great Master" really tells him about some definite modern problem, say time. Imagine his satisfaction at having it revealed to him at the outset that "the Present" is "the transition of Being into Nothing, or of Nothing into Being" (§ 259). A watchmaker might be equally pleased to learn in some supposed supreme treatise on his art, that a chronometer is a continued Identification of the Now. Perhaps the most definite thing regarding our subject which we learn of Hegel, is that, in comprehensible moods, he classed time as a "Pure form of Sensibility." (§ 258).

ARTHUR SCHOPENHAUER declares "From Kant's doctrine of the Transcendental Aesthetic, I know of nothing to take away; only of something to add." What he "adds" particularly for us, the following will indicate: "Time is primarily the form of inner sense. . . . The only object of inner sense is the individual will of the knowing subject. Time is therefore the form by means of which self-consciousness becomes possible for the individual will, which originally and in itself is without knowledge. In it the nature of the will, which in itself is simple and identical, appears drawn out into a course of life."[2] Also, "Time, space, and causalty are that arrangement of intellect by virtue of which the *one* being of each kind which alone really is, manifests to us a multiplicity of similar beings, constantly appearing and disappearing in endless succession."

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[1] Gesch. d. Philos. § 318. Tr. p. 567.
[2] World as Will and Idea. Tr. Haldane and Kemp. (Boston, 1888) Vol. II, p. 33.
[3] p. 207.
[4] p. 224.

In a more empirical mood he declares "Succession is the whole nature of time";[1] this is adverse to the side of the great debate which Fichte took in declaring time to be not "succession" but a "present thought."

CHR. HERMANN WEISSE and I. H. FICHTE (half-Hegelians) criticised their master for not treating space and time as any of the other categories of knowledge or "forms of reality," and in his Logic rather than in his Philosophy of Nature.[2] Fichte developed space and time from certain "*feelings of duration and extension which are inseparable from self-consciousness, and which feelings have their basis in the soul's own objective nature.*"[3] From a similar standpoint, E. H. WEBER, in 1852, coined the now famous phrase "*The Space-sense*," and following him CZERMAK first used its analogue "*The Time-Sense.*" These are important events in the experimental history of time. Weber and Czermak looked upon space and time as being senses as disparate as sight and hearing. Yet from their universality they called them General Senses as opposed to the special.[4]

FRIES was most influenced by Jacobi, but declaredly clung to Kant's views of time.[5] Yet he distinguishes between *à priori* "cause" of intuition, and intuition *per se*.[6] He begins to take the bodily organism a little into account,[7] and was troubled as to what *particular* time-relations would be perceived from Hume's mere sequence of notes; but he thought "in some sort of a way I get possession of these co-existently" (p. 142). He vaguely described this "some sort of a way" as "a fundamental determination or fixing of the mind."[8] He declares that all sense perception must appear in the mind "joined" (*verbunden*). Particular time-relations Fries derives from the "reproductive" and "produc-

[1] p. 9.
[2] Article by Weisse in Fichte's Zeitschrift, 1837.
[3] Ibid, new Vols. 55, p. 237 sq.; Vol. 56, p. 47, sq.
[4] Weber, Berichte ü. d. Verhandlungen, d. K. S. G. W. Math. Physische Classe, 1–4, S. 85. Jahrgang, 1849–52. Czermak — Gesamm. Schriften, I, 416.
[5] Kritik d. Vernunft (Heidelberg, 1828), Vol. I, p. 173, etc. Erdmann's Hist. Philos. (Tr. 1890), II, 454.
[6] p. 173 sq.
[7] p. 94.
[8] p. 69, 106, 110, 120, 124, 141, *171*, 174, *177 sq.* 188.

tive powers of Imagination"; by which they are "attributed" their proper time-aspect in the passing content of mind.[2] In proportion as he conceived the course of our thoughts to be determined at will, these time-aspects were bestowed voluntarily.[3] Yet more than any German of his day he gave consideration to the rôles which memory,[4] association, habit, training,[7] "former occurrence,"[8] "fading,"[9] etc., play in "mental inter-determination." In these he is abreast with the best of the Scotch-English school of his day. In all but the vague "some-sort" of intuition of sequence, Fries' time-relations are *perceptive acts*.[10] He also inclined to a more objective conception of space and time than Kant, in that he at times conveys the idea that space is "visible extension void of particular or limited content"; and that time is some sort of analogous objective inner sense. Fries is also more generous to realism than Kant, and is inclined to conceive relations actually existing between things, to which in themselves he consequently carries over Space, Time, Motion and Change.[11] In view of the importance which the phrase, "The idea of succession is not a succession of ideas" assumes in subsequent stages of the discussion, it is important to note that Fries apparently was the first definitely to emphasize the declaration that "all the terms or elements of unification, comparison or relationship must be before consciousness at the same time."[12]

THOMAS REID deserves great credit for bringing out many of the difficulties of the problem to clear and simple view. He declares: "I think it would be impossible to show how we could acquire a notion of duration, if we had no memory." This is against Kant's view. "Memory implies a conception and a belief of past duration. . . . Remembrance is a

[1] p. 102, 137, 145, 161, *175*, 177, 178 sq., 185, 188, 192.
[2] p. 161, *175*.
[3] p. 77, 83, 163, 185, 187 sq., 196.
[4] p. 135 sq. 161, 165.
[5] p. 142, 148, 153 sq., 160, 162 sq., 187 sq., 193.
[6] p. 168.
[7] [8] p. 137, 160, 162 sq., 165.
[9] p. 138.
[10] p. 86.
[11] p. 77, 83, 163, 185, 187 sq., 196.
[12] p. 141, 180.

particular act of the mind of which we are conscious. . . . I believe that I washed my hands and face this morning; how do I come to believe it? I *remember* it distinctly—that is all I can say. . . We know many past events by memory; but how it gives us this information I believe is inexplicable. . . . I think it appears that memory is an original faculty, given us by the author of our being of which we can give no account, but that we are made so. . . . All our original faculties are unaccountable."

Yet Reid makes contributions to the time-problem. He takes Locke to task for confounding succession with duration: "the notion or idea of duration must be antecedent to its being measured"—to succession.[1] Also we must crown Reid for grasping more definitely than anyone before his time this cardinal aspect of the subject: "It may be observed," he says, "that if we speak strictly and philosophically no kind of succession can be an object of either the senses or of consciousness; because the operations of both are confined to the present point of time, and there can be no succession in a point of time; and on that account the motion of a body, which is a successive change of place could not be observed by the senses alone without the aid of memory" (p. 348). Criticising Hume for saying that impressions reappear, he declares "the thing is impossible." "Impressions are fleeting perishable things, which have no existence but when we are conscious of them" (p. 357). He makes rather lame fun of Hume's explanations of time by "reappearances of varying intensity." "Suppose a man strike his head against the wall, this is an impression; now he has a faculty by which he can repeat this impression with less force. . . . This by Mr. Hume's account must be memory" (p. 357). Reid admits that "it is probable that in the human frame memory is dependent on some proper state or temperament of the brain; yet says he "if we knew distinctly that state of the brain which causes memory we should still be as ignorant as before how that state contributes to memory" (p.354); "an ability to revive our ideas or perceptions after they have

[1] Works. Edinburgh, 1872, p. 339–360.

ceased to be, can signify no more but an ability to create new ideas or perceptions similar to those we had before" (p. 355). How we recognize perceptions we have had before, is to Reid inexplicable.

DUGALD STEWART advances our problem only in a general way by forcible analysis of such questions as Identity, Association, Memory and Reason. He says, "the idea which is commonly annexed to *intuition* as opposed to *reasoning*, turns, I suspect, entirely on the circumstance of time."[1] "For this reason I look upon the distinction between our intuitive and deductive judgments as, in many cases, merely an object of theoretical curiosity" (p. 71). He declared like Reid "the theories which attempt to account for the phenomena of memory by means of impressions and traces in the brain, are entirely hypothetical, and throw no light on the subject which they profess to explain" (p. 393).

THOMAS BROWN deserves conspicuous rank among the Fathers of Psychology. One of his services was to disclose (it is not yet dispelled) what Prof. James calls the "Great Psychological Fallacy;" this consists in unconsciously carrying over and accrediting to some psychological act or phenomenon which we may be analyzing, those other feelings, mental acts or states which we have *while* introspectively making this analysis. This fallacy had led to the great debates before Brown's day, relative to the distinction between sensation and perception, till then it having been almost universally maintained that perception included self-consciousness, a knowledge of *a* mind looking on *at* mind. Brown says, "to me it appears, that this attempt to double, as it were, our various feelings, by making them not to constitute our consciousness, but to be the object of it, as of a distinct intellectual power, is not a faithful statement of the phenomena of the mind. . . . . Sensation is not the object of consciousness different from itself, but a particular sensation is the consciousness of the moment. . . . 'I am conscious of a certain feeling' really means no more than 'I feel in a certain manner.'"[2] Also Brown's revelations regarding the genesis and make-up of

[1] Works—(Cambridge, 1829), II p. 69.
[2] "Lectures on the Philosophy of the Human Mind." (Philada. 1824), Vol. I, p. 135, sq.

our conception of space are important contributions to psychology; from these he carried over certain analogous determinations to the enrichment of the time problem. Having deduced the notion of space from motion, and that of length from continued or successive motion, he conceived the origin of the idea of time to lie in identically the same thing—that length of extension and length of duration are ultimately one —(p. 305). He discovered this element of length in all mental processes. "Continuous length and divisibility, those great elementary notions of space and time and of all that space contains, are thus found in every succession of our feelings" (p. 306). He also gives us a nearer view of their development. "If," says he, "we gradually extend our arms in various directions, or bring them nearer to us again, we find that each degree of the motion is accompanied with a feeling that is distinct, so as to render us completely conscious of the progression. The gradual closing of the hand, therefore, must necessarily give a succession of feelings, a succession, which of itself might, or rather must furnish the notion in the manner before stated, the *length* being different according to the degree of the closing, and the gradual stretching out of the arm gives a succession of feelings, which in a like manner must furnish the notion of length—the length being different according to the degree of the stretching of the arm. . . . The Infant . . . by frequent renewal of the series of feelings involved in each gradual contraction, cannot fail to become so well acquainted with the progress as to distinguish each degree of contraction, and at last, after innumerable repetitions, to associate with such degree, the notion of a *certain length of succession*. . . . In these circumstances of acquired knowledge (after the series of muscular feelings, in the voluntary closing of the hand, has become so familiar, that the whole series is anticipated, and expected as soon as the motion has begun) when a ball or any other substance, is placed for the first time in the infant's hand, he feels that he can no longer perform the usual contraction; or in other words, since he does not fancy that he has muscles which are contracted, he feels that the usual series of sensations does not follow his will to renew it; he knows how much of the

accustomed succession is still remaining, and the notion of the particular length which was expected and interrupted by a new sensation, is thus associated with the particular tactual feeling excited by the pressure of the ball. . . . By frequent repetition and association . . . these two feelings flow together; . . . it becomes, at last, as impossible to separate the mere tactual feeling, from the length of feeling (time) as to separate the whiteness of a sphere in vision, from that convexity of the sphere, which the eye, of itself, would have been forever incapable of perceiving" (p.309 sq.). "The series of muscular feelings of which the infant is conscious . . . must on these principles, be accompanied with the notion . . . of a certain length of succession, and each stage of the contraction, by frequent renewal, gradually becomes significant of a particular (time) length corresponding with the portion of the series" (p. 297). These deductions hold of all, as well as of the muscular sense. "Time or succession then, involves the very notion of longitudinal extension and divisibility and involves these, without the notion of anything external to the mind itself; for though the mind of man had been susceptible only of joy, grief, hope, and the other varieties of internal feeling, *without* the possibility of being affected by external things, he would have still been capable of considering these feelings as successive to each other in a long continued progression, divisible into separate parts. The notion of length, then, and of divisibility, are not confined to external things, but are involved in that very memory by which we consider the series of the past, not in the memory of distant events only, but in those first successions of feeling by which the mind originally becomes conscious of its own permanence and identity. The notion of time, then, is precisely coeval with that of the mind itself; since it is implied in the knowledge of succession, by which alone, in the manner above explained, the mind acquires the knowledge of its own reality, as something more than the mere sensation of the present moment. Conceiving the notion of time, therefore, that is to say, of feelings past and present, to be thus one of the earliest notions which the infant mind can form, so as to precede its notions of external things, and to involve the

notions of length and divisibility, I am inclined to reverse exactly the process commonly supposed, and instead of deriving the measure of time from extension, to derive the knowledge and original measure of extension from time" (p. 307).

This is one of the most noteworthy passages in the history of our subject; particularly so when we compare its truly remarkable penetrations and suggestiveness with its glaring contradictions; evidently the crucial question, whether time is an idea or a succession of ideas had not come to a focus in the mind of this acute psychologist; within short spaces he confounds the two concepts in a way that must necessarily lead him to false conclusions.[1] All through the above discussion we have been led to believe that the idea of time lies in the successions themselves, in precisely the same way as Brown took so much pains to explain that "perception of a sensation" was the sensation itself; but the moment he takes up the subject of time under another aspect—that of memory or of relations—his traditions prove stronger than his originality, and he tells us that "*certain feelings of relation*" constitute our notion of time.

Before examining this let us make sure what, in the conception of this great mental-chemist, these "relations" were. He says, "the feelings of relations are states of the mind essentially different from our simple perceptions or conceptions of the objects that seem to us related, or from the combinations which we form of these in the complex grouping of our fancy." "There is an original tendency or susceptibility of the mind, by which on perceiving together different objects, we are instantly, without the intervention of any other mental process sensible of their relations in certain respects, as truly as there is an original tendency or susceptibility of the mind, by which, when external objects are present and have produced a certain affection of our sensorial organ, we are instantly affected with the primary elementary feeling of perception." "As our sensations are of various species, so are there various species of relations . . . the number of relations, indeed, even of external things being almost infinite," etc., (p. 146).

[1] Compare p. 297 with p. 307.

We now may understand Brown when he says "time, as far as we are capable of understanding it, is nothing more than the varieties of the felt relation; which in reference to one of the subjects of the relation we distinguish by the word *before*, in reference to the other, by the word *after* . . . All of which we can be said to be *conscious*, is certainly the present moment alone. But of that complex state of mind, which forms to us the present moment, there are parts which impress us irresistibly and beyond all the power of scepticism with the relation, which, as I have already said, we term *priority* in reference to the one, and *succession* or *subsequence* in reference to the other; time as felt by us, being this relation of the two and nothing more."[1] . . . "It is a relation we may remark, which we feel, nearly in the same manner as we feel the relation which bodies bear to each other as co-existing in space."

This last is remarkable from one who has deduced space from time—from the mere successive feelings of "length" in stretching the arm. Also Brown's genesis of time as detailed above, and his notion that time is one of the earliest notions of the infant, "preceding its notion of external things," are difficult to reconcile with his declaration that "if we had been incapable of considering more than two events together, we probably never should have invented the word time" (p. 90). We have to regret that Brown did not give the same weighty scrutiny to "relations" which he gave to the analysis of space.

Brown developed further the common doctrine of association or "suggestion" as he termed it, by adding thereto a further class or realm, of association among "relations"; the former he termed "simple suggestion;" the latter "relative suggestion." Among these last he classed time perception. Thus it must be observed, though arrived at from entirely different standpoints these "*feelings* of time relation" are essentially kin to the disparate "time-sense" of Czermak and Vierordt, and the time "feeling" of I. H. Fichte, and as we shall see later of Horwicz, and James.

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[1] Ibid, Vol. II, 91.

SIR WILLIAM HAMILTON falls back from Brown toward Kant. He nowhere gets beyond the antique vagueness that "time is the necessary condition of every conscious act."[1]

HERBART is the Morning Star of modern German Psychology. Schwegler describes his system as "an extension of the Monadology of Leibnitz."[2] Herbart's monads, however, are "eternally unchangeable," and in place of the Pre-established Harmony of Leibnitz, the reciprocal interactions of the monads or "reals" are the direct cause of their intelligence. The diversities of mental content are primarily due to respectively diverse kinds of "reals"—for every red, shrill or cold sensation, a red, shrill, or cold monad.[3] Mind as the product of the interactions of these monads is a mathematical mechanism.

The following indicates Herbart's mechanism of time. Some "real" attacks our "real" (the soul) which "seeking to preserve its own condition," a corresponding sensation *a* results; *a* thus rises in consciousness till equilibrium is reached between the force of the "real" and the "self-preserving" force of the soul; *a* "sinks" as the soul gains the mastery and restores itself by expelling the attacking "real." The level at which any consciousness begins is its "threshold."[4] If while *a* durates in consciousness, another sensation *b* similarly rises, then *a* and *b* "fuse" (associate) proportionately to their "remnant" or remaining co-presence, height or intensity in consciousness; thereafter, whenever either *a* or *b* appears in consciousness, it tends to bring back the other with a force proportional to the above "fusion." If *a b c d* rise in an original sequence, and *a* by any cause be brought back into consciousness, it will tend to bring with it *b; b* to bring *c;* and *c* to bring *d;* thus the whole series will repeat itself in the time order of its original occurrence.[5] If, moreover, at any time thereafter *c* be the first of the series to be brought back, then its influence will work in two directions; the series *c d* will repeat itself as in the original

[1] Lectures (Boston, 1871), I, 548.
[2] Hist. Philos. (Sterling Tr. Edinburgh, 10th Ed.) p. 285.
[3] Lehrbuch zur Psychol., § 150 sq., etc.; Allgemeine Metaph. § 312, "Wie viele Merkmale—so viele Ursachen."
[4] Lehrbuch, ch. 1.
[5] Ibid. § 29 sq.

sequence; but at the same time *c* will act both upon *b* and upon *a* in proportion to its former "fusion" with each of these; consequently, while *c d* reinstates itself as a "series of evolution," the combination *a b c* rises simultaneously through "involution" *c* appearing brighter than *b*, and *b* than *a*, *i. e.*, fixedly in proportion to their original fusion—that is again, in brightness proportional to the time-order of their original appearance.[1] These laws may be carried out through all the familiar complexities of Association, "series and ever-compounding series of series" being substituted for the letters of our formula.

But in particular how are time-perceptions formed? Suppose an original series *a b c d e*, as above. Should *a* be again presented the series tends to repeat itself by "evolution" in its original direction. Should *e*, however, be the first to appear of a re-presentation, then the series tends to be brought back as a whole, co-existently and by the above process of "involution." Finally, should *a* and *e* be reproduced *simultaneously*, a compound result would now occur; a result including and combining both the previously mentioned results: that of the "involution," occurring from *e*, and the "evolution" following from *a*. In this final process, it will be observed, are involved three requisites: (1) *The involutive product*—in which all the members of the series are simultaneously represented, but each with a brightness corresponding to its time order or degree of "fusion" in the original sequence. This may be called the *presentation of the series*. (2) *The evolutive product*—which is an actual re-occurrence of the original series in the same time order, and each member in proportion though not with equal brightness, with that in which it first appeared. This may be called the *presentation of the succession*—that is, of the process itself or of change. (3) By the combination of (1) and (2) the two end terms of a series are presented in a proper double simultaneous relation, that is as both co-existently *present*, yet both also in serial perspective of fixed single direction. This may be called *the presentation of their terminal time-relation*. Thus in (1), (2) and (3) together, we have the three elements,

[1] Ibid. § 167 sq.; 75 sq.; 89 sq; Psych. als W. § 94, 112, 115.

which Herbart conceived to be essential to a complete perception or idea of time; namely: An idea of the series, an idea of succession or change, and an idea of definite terminal relations.[1]

Suggestive as is the method, and scientific as is the spirit of Herbart's time theories, it is of chief importance for us to note accurately Herbart's true position regarding time-perception as an instantaneous state, or a succession of states; this especially because of the weight of Herbart's opinion as an authority; of his great influence upon the German Psychology of to-day; of the constant misconception and misquotation of his opinion, and of the crucial value of the question itself. By holders of the first view, much is made of Herbart's phrase, "Succession in presentation is not a presentation of succession."[2] While to any student of Herbart it is plain that *not every* succession of mental content suffices to constitute or yield an idea of time-relation, yet it is just as plain that no single *simultaneous* condition of mind does or can constitute the same. Herbart's time-perception is a three-fold *process*—not a single present *state*. It is also important to note that Herbart imports into his three-fold process no extra or disparate sense or feeling; *Herbart's perception of time-relation, consists of certain proper successive combinations of our ordinary sensations or feelings, or of their reproduced representatives.*

FRIEDRICH EDUARD BENEKE founded a new psychological system more or less kin to that of Herbart and to the English Empirical School, but he gave no new explanations of time.[3]

MORITZ WILHELM DROBISCH, a disciple of Herbart, declared space and time to be but "forms of succession" (*Reihenformen*).[4]

THEODOR WAITZ, from an Herbartian starting point,[5] introduces a new aspect of the problem—one that assumes great importance in the modern psychology of Wundt, Münsterberg,

[1] Ibid. § 167 sq.; § 75 sq.; § 89 sq. Psych. als W. § 94 sq.; § 112 sq.; § 115.
[2] Lehrbuch zur Psych. § 174; Allg. Metaph. ch. 1 sq.
[3] "Die neue Psych." Berlin, 1845; Lehrbuch d. n. Psych. 2d Ed. (Berlin, 1845); Pragmatische Psych. (Berlin, 1850), 2d Ed.
[4] Empirische Psych. (Leipzig, 1842), p. 67.
[5] Lehrbuch der Psych. (Braunschweig, 1849), p. 580, 583.

et al. He points out that "certain conditions of feeling" such as constitute waiting, impatience, tediousness, straining of attention and the like, always accompany our objective contents of thought; and he holds that these are fundamental in the formation of our time percepts. The process by which this happens is not unlike that given above from Thomas Brown. A well remembered series of these obscure inner feelings, that is, a series of them which has been frequently repeated in us, is compared with, that is, "*runs its course simultaneously with*" a new objective series, say of vision: the new visual series over-runs, or runs short of the old constant series of feelings, and the shortage or overplus of these last constitute our means of judgment, or time-measures of the new series. These overplus and shortage earmarks become "fused" or associated with all sorts of combinations and abstractions, and form the fundamental measure elements of all our time concepts.[1]

RUDOLPH HERMANN LOTZE, notwithstanding his eminence in modern philosophy and the originality of his determinations regarding "local signs" and space, adds little to the discussion of the time problem. He believed in the "power of the soul to preserve impressions independently of physical conditions."[2]

HEINRICH CZOLBE, of all moderns, must be credited with the most unique view of time. He regarded all sensation as extended in space, and time as a fourth dimension of space.[3]

WILHELM ROSENKRANTZ, last of the School of Schelling, newly discussed time as a category or form of thought in its intercourse with the outer world.[4]

LEOPOLD GEORGE, pupil of Schleiermacher and Hegel, declared: "By means of memory the moment of time is introduced in the [*i. e.* his] system of localized points"; but "memory does not reproduce traces of sensation as is generally thought, but reproduces combinations, the occasions

[1] Ibid. § 52.
[2] Medicin. Psych. § 36, p. 473.
[3] Posthumous Work, "Outlines of an Extensional Theory of Knowledge. Edited by Dr. Johnson (1875). Compare with this from Diogenes L. VII, 141, "Time is the extension of the motion of the world (*διάστημα τῆς τοῦ κόσμου κινήσεως*). It is infinite both in the direction of the past and of the future.
[4] Die Wissenschaft des Wissens (Munich).

for which have been supplied by the sensations."[1] Particularly he combats the time theories of Trendelenburg.

TRENDELENBURG, going back to Aristotle, held space and time to be products of motion.[2] In opposition to Kuno Fischer he particularly criticized the time theories of Kant and Herbart.[3]

ULRICI examines the subject from the stand-point of "Speculative Theism," and semi-Hegelianism, but gets little further than such declarations as that "Thought is bound by certain rules, of which time is one."[4]

FECHNER discusses time, space and motion, as it would seem, with particular reference to the writings of Trendelenburg, but without his usual originality.[5]

BRENTANO, Professor of Philosophy at Vienna, in his Psychologie vom empirischen Standpunkte (Leipzig, 1874), gives an interesting exposition of the views of a certain current transitional school, but does not focus definitely on the subject of time.

HORWICZ is a prominent advocate of the modern tendency to make physiology the sole source and guide of both psychology and philosophy.[6] The metaphysical question of *how* the body excites any feeling at all in the soul, he considers vanity and folly. (I. 143). Soul is "a collective designation for all psychic phenomena." (I. 135). He reduces all of mind to simple elements of "feeling." Change in feeling follows change in nerve substance. (2 Vol. III, 41). "All soul processes are built up (of the ultimate feeling elements) through repetition and complication." (I, 202). Frequence of repetition plays the fundamental rôle (p. 345 sq.). Certain frequency gives us sight, another sound, etc. Time-sense, and space or place sense are special senses to be classed

[1] Lehrbuch der Psych. (Berlin, 1854). p. 222, 399.
[2] Logische Untersuchungen (Berlin, 1840). Vol. VI.
[3] Vol. III. Hist. Beiträge zur Philos.; (pamphlet) "Kuno Fischer und sein Kant" (Leipzig, 1869); K. Fischer's Geschichte d. neuren Philos. (2d ed.) Vols. III and IV, 1869.
[4] Das Grundprincip der Philosophie, Leipzig 1845–6; System der Logic (1852); Compendium der Logik (1860 and 1872); Outline of Practical Philos.. pp. 1–208.
[5] Physik. u. Philos. Atomenlehre (Leipzig, 1855–1864). Appendix.
[6] Psychologische Analysen auf physiologische Grundlage, 1st Part. Halle, 1872, 2d Part (2 Vols. Halle und Magdeburg, 1875–1878).

with sight, hearing, etc. (p. 340). This, though time appears *only with* and *always with* other sensation. Horwicz's classification of the senses, according to their *objectivity*, is strangely in opposition to Kant: "Objective (end of scale); Time-sense, space-sense, eye, ear, pressure, temperature, smell, taste, general feeling of the skin, feeling of the organism or general feeling; subjective (end of scale.)"

Sensations, on their physical side, leave effects in the nerve elements, which are the basis of our ideas or reproduced sensations. Metaphysical identity Horwicz declares to be an insolvable metaphysical question, but mental or objective identity is at least an "unsuspected likeness" (p. 107). From reappearances of these unsuspected likenesses under the usual laws of reproduction and association, Horwicz builds all our concepts of memory and of time-relation. He plants himself unmistakably on the side of those who declare all perceptions of time-relation to be only certain successions of properly compounded sense presentations, or feelings.

Horwicz betrays the influence of modern experimental time psychology; rhythm now plays the important rôle. Rhythm he declares to be the measure and the only measure of time; a being incapable of regular periodic intervals could attain no conception of time. All the rhythmic functions of the body serve this purpose; as breathing, pulse, leg-swing and other such movements, hunger, sleep, labors, duties, customs of all kinds. Thus our time measures spring from and enter into the most fundamental and most subtle depths of our being (III, 145).

WILHELM WUNDT, at present the most conspicuous figure in German Psychology, has given us positive determinations of unusual originality and value; this whether the merit of his system be as entirely obvious or not.[1] He reduces all mind to ultimate elements of "will;" indeed, elementary acts of will, as activities, rather than as sensations, are the ultimate constituents of the entire universe.[2] Higher manifestations of these elementary will components are feelings and

[1] For English criticism see "Mind," January, 1890.
[2] System der Philosophie (Leipzig 1889), p. 438

sense-perceptions. Combinations again of these last mentioned products, give us sensations proper, but as a matter of fact, we never experience even sensations, as single elements, but alone complex combinations of them, such as our ordinary complex sights, sounds, etc.[1] The nature of this lowest element of mind is, however, that of a judgment; in the merest experience, say of red, is a recognition—a judgment of it as red. Therein lies the root and nature of all reason, of all mental acts; which acts are but complications or compilations of elementary willful judgments.[2] Inherent in the nature of this ultimate unitary judgment, is the problem of recognition of identity.[3] Why elements of mind exist at all we do not know; why diversity rises from these units we do not know; why we judge or identify the diverse we do not know. That we *do* these things is assumed as an ultimate fact. From these ultimate assumptions all mind develops; the processes of its development are alone the province of psychology; what may lie back of these is the province of metaphysics.

In the same way that the *content* of mind is ultimately incomprehensible, so also is the fact that its diversities succeed each other; the nature and the manner of these successions is all that psychology can study. All mind then is but a succession of diversities; certain of these we call ideas, perceptions, conceptions or postulates — among others are those of time.[4] Yet not every mental succession suffices to constitute an idea or perception of time—an idea or even the simplest possible perception being a highly complex product. The crucial process of time-perception Prof. Wundt describes as follows: "Assume that . . . similar pendulum strokes follow each other at regular intervals in a consciousness otherwise void. When the first one is over, an image of it remains in the fancy until the second succeeds. This, then, reproduces the first by virtue of the law of association by similarity, but at the same time meets with the aforesaid persisting image. . .

[1] Grundzüge der Physiologischen Psychologie (Leipzig 1887) II, 226.
[2] System, p. 573.
[3] System, p. 504.
[4] System, p. 428 sq; 431 sq.

Thus does the simple repetition of the sound provide all the elements of time-perception. The first sound [as it is recalled by association] gives the beginning, the second the end, and the persistent image in the fancy represents the length of the interval. At the moment of the second impression, the entire time-perception exists at once, for then all its elements are presented together, the second sound and the image in the fancy immediately, and the first impression by reproduction. But, in the same act, we are aware of a state in which only the first sound existed, and of another in which only its image existed in the fancy. Such a consciousness as this is that of time. . . . *In it no succession of ideas takes place.*"[1]

It can not fail to be observed that the above time-perception is a *process* and not a *state*. Notwithstanding Wundt's last words in italics this process is surely a succession of some kind or kinds; though of course it is not a "succession of ideas," if by idea is meant the process as a whole. There seems no good reason for confusion on this point.[2]

Prof. Wundt discusses constancy (duration), change, and rhythm with perspicuity and truth.[3]

Prof. LIPPS one of the representative German Psychologists describes the time-process as follows: "Sensations arise, occupy consciousness, fade into images and vanish; according as two of them, *a* and *b*, go through this process

[1] Physiological Psychol. 1st Ed. p. 681-2. Tr. in James' Psychology, Vol. I, 608. James adds "note here the assumption that the *persistence* and the *reproduction* of an impression are two processes which may go on simultaneously. Also that Wundt's description is merely an attempt to *analyze the deliverance* of a time-perception, and no *explanation of the manner in which it comes about.*"

[2] Prof. Wundt contributes confusion as follows: Logik p. 432. "Die Vorstellung zeitlicher Aufeinanderfolge ist nicht selbst eine Aufeinanderfolge von Vorstellungen, sondern eine aus der letzteren hervorgehende *simultane* Anschauung, in welcher sich die Wahrnehmung zweier getrenter Vorstellungen, die als Anfangs- und Endpunkt einer Zeitreihe gegeben sind, mit dem Bewusstsein eines sie trennenden andersartigen Inhaltes verbindet. Dabei kann dieser letztere, entweder bloss aus der Nachdauer der ersten Vorstellung, oder ausserdem, aus neuen Vorstellungen bestehen, deren Nach-wirkungen zu derjenigen einer ersten Vorstellung hinzu tretten. Wesentlich für die Anschauung der Zeit, ist somit, einerseits die Verbindung verscheidener getrennter Vorstellungen mittlest der Reproduction, und anderseits das ebensfalls durch Reproduction vermittelte Bewusstsein ihrer Trennung."

[3] p. 435.

simultaneously, or as one precedes, or follows the other, the *phases of their fading* will agree or differ; and the difference will be proportional to the time-difference between their several moments of beginning. Thus there are differences of quality in the images, which the mind may *translate* into corresponding differences of their temporal order. There is no other possible middle term between the objective time-relations and those in the mind than these differences of phase."[1]

Prof. Lipps calls these "temporal signs"; what his process of mental translation of these signs may be is difficult to conceive, and it were about as easy to call the whole problem an inexplicable mystery and be done with it.

ERNST MACH, a prominent representative of the experimental school, also carries back our problem to a special time-*sense* or feeling, "as special as that of color."[2] He says we can separate the rhythm of a melody from the tone, as much as the contour from a painting, and that this would not be possible were the rhythm not a separate series. He suggests that there may be in the ear some accommodation apparatus like that of the eye, which may be the organ of the temporal sense. Time-sense, therefore, would be, and is closely allied to the workings of attention; certain "fixation" sensations arise from this accommodation organ, varying according to intensity, duration, pause, etc.; a greater amount of attention always indicates the *later* impression; this happens by reason of association with sense of fatigue of the organ. "But adapted condition" would in time be called up by external happenings, as in eye-adaptation and these called-up ear-marks thus give us temporal distance and sequence, in the same way as we get visual distance and perspective.[3]

DR. HUGO MÜNSTERBERG finds in respiration a solution of the time-problem (analogous to Mach's theory above) which

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[1] Grundtatsachen des Seelenlebens (Bonn, 1883). p. 588. Tr. James' Psy. p. 632.

[2] "Untersuchen über den Zeitsinn des Ohres," § IV. "Beiträge zur Analyse der Empfindungen," pp. 6–14.

[3] Ibid, p. 103 sq.

will be considered presently in connection with the work of other experimentalists.

Prof. WILHELM VOLKMANN discusses time with his usual comprehensiveness. A brief review of his discussion will close the history of the German schools, and thus, what may be considered a fair representation of the latest status of our problem in that country, will be brought into close comparison with the views of James Mill of the English school, which will then follow.

The general system of Volkmann is so essentially that of Herbart as to need no further exposition here. Regarding time, however, Volkmann takes a more literal position than his master as to whether the idea of succession is or is not a succession of ideas. He says: "Indeed when one considers the matter precisely, he discovers the antithesis, that the presentations *A* and *B*, in order to be perceived as successive, must be presented simultaneously; that is, in order to *appear* to be after each other, they must *be* present."[1] "In order to become conscious of a presentation as ended, we must bring it into some other presentation which appears to us as going on." In original sensations as opposed to their reproduced images he finds the requisite data of distinction for the "going on;" these form our present. Of a succession of sensations *A B C* only one is present—"the present of one excludes that of the others. But this exclusion is purely negative; if a time-presentation is to arise, the not-present (say of *A* and *C*, while *B* is present) must be raised from the negative to the positive form." "This happens in that *A* and *C* (while *B* is present) each in a different manner, continue to influence B" (according to ordinary Herbartian psycho-mechanics). *A*, although having passed out of the focus of sensation, struggles to preserve to itself that condition as against *B*; *B* repells this endeavor, and in the reflex, which the presentation of *A* in itself suffers, lies the perception *(Bewusstwerden)* of time as *a quality of A, i. e.* the perception of it as "no more." Thus with Volkmann this secondary reflex feeling of strife,

[1] Lehrbuch der Psychologie von Standpunkt des Realismus (Cöthen, 1885), II, p. 12.

suffered by reason of the contention of the sensations themselves for the focus-point or present of consciousness, is the essential element of time-perception. Similarly to this struggle of "no-more," or "feeling of past," of *A*, is developed the "not-yet" of *C*, *i. e.*, the feeling or intuition of future. The time-sense with Volkmann is, therefore, more thoroughly a disparate sense, though also a "general sense," than even sight or hearing.

"No-more and not-yet," he continues, "are the specific *(eigentlichen)* time-feelings, and we should never become conscious of time otherwise than through these feelings. . . . When a series has once taken on this time-form (as above) it preserves the acquired characteristic, in future reproduction of the same, but only when, and in so far as the same conditions are renewed, under which the original time-form was developed. . . . The presentations *(A B C)* remain what they are, but the manner of their presentation changes; all time-consciousness, as feeling, is a perception (*Bewusstwerden)* of presentations" (§§ 86, 87).

Regarding duration, a corresponding struggle to that of "no-more" and "not-yet-there," gives us the feelings of "yet-there." Complications of these constitute our feelings of tediousness, ennui, expectation, monotony, haste, fast, slow, etc. "The rise and fall of these strifes, bring into the life of the individual certain rhythms" which become our measures of duration and of time. So separate is the *sense* of time from the *content*, that various presentations may produce the same feelings of time or of duration, *i. e.*, the same perceptions of time-length and time-relationship (§ 88).

Upon these main principles, Volkmann develops all the more varied and complicated time concepts, up to those of eternity and of time in the abstract. This, in a truly masterly manner, whether the fundamental metaphysical assumption of all his strife mechanism between mental elements be in any way warranted or not.

JAMES MILL follows Thomas Brown in denying any difference of essential nature between sensation and perception. He took upon himself the task of removing still more completely the "Psychological Fallacy" of self-consciousness,

from our conceptions of mental processes.[1] Yet Mill was not altogether able to free himself at once from the inbred uses of language, or even from the habits of thought current in his age, and indeed still current in the popular psychology of today. If, however, Mill's point of view be borne in mind and his meaning be sought for with any generosity and fairness, psychological truths and subtle suggestions of the profoundest and most far-reaching importance may be found in his writings in germ, if not always fully developed.

Time, memory and personal identity are intimately intertwined; the same fundamental mystery lies at the root of all three. With Herbart and his school Mill distinctly declares that not any and every mental succession will give us a perception either of time-relation, of memory, or of identity: and in close accord with Herbart, he asserts, that *certain proper successive combinations of sensations, their reproductions, and repetitions of these reproductions do alone and of themselves constitute all possible forms of all three.* He says: "Imagination consists of ideas. . . . Memory has in it all that imagination has, but it must also have something more. . . . In memory is not only the idea of the thing remembered, there is also the idea of my having seen it. Now these two, (1) the idea of the thing, (2) the idea of my having seen it, combined, make up, it will not be doubted, the whole of that state of conscience which we call memory. But what is it that we are to understand by what I have called 'the idea of my having seen the object'?" (p. 32d). To clear up this question he supposes a case as follows: "I have one sensation, and then another sensation; call them *A* and *B*, and I recognize them as successive." Then, "the consciousness of the present moment (by law of association) calls up the idea of the consciousness of the preceding moment. The consciousness of the present moment is not abso-

[1] "Analysis of the Phenomena of the Human Mind" (London, 1869) I, p. 235. A pregnant passage in Mill is "The term 'I conceive' has the form of an active verb, and with the form of an active verb, the idea of action is so frequently conjoined that we are rarely able to separate them." Perhaps the chief point of difference in the general systems of Brown and Mill is, that the latter abandons "relations" as a separate element or phenomenon of mind.

lutely simple; for whether I have a sensation or idea, the idea of what I call myself is always inseparably combined with it. The consciousness then of the second of the two moments in the case supposed, is the sensation combined with the idea of myself, which compound I call 'Myself Sentient.' This Self Sentient, in other words, *sensation B combined with the idea of self*, calls up the idea of *sensation A combined with self*. This we call Memory" (p. 337). Memory then, Mill finds to consist of three parts: "the remembering self; the remembered self; and the train which intervened. Of these three parts, the last has been fully expounded. The recalling of the successive states of consciousness, which composed the intervening train, is an ordinary case of association; the other parts, *the two selves*, at the extremes of this train, require further consideration. The self at the first end, is the remembered self; *the self which had a sensation or an idea*. The idea of this self, therefore, consists of two parts: of self, and a sensation or an idea. The last mentioned part of this combination, the sensation or idea, needs no explanation; the first, that which is called self, does. The self at the other extremity of the chain of consciousness, is the *remembering self*. Remembering is associating. The idea of this self, then, is the combination of self with the idea of associating. And here, too, associating needs no explanation; it is the other part of the combination that does. The analysis, then, of self, or the account of what is included in that state of consciousness commonly called the *idea of personal identity*, is still wanting to complete the development of memory" (p. 338). In modern times the associational conception of self, or personal identity, is too well known to need here that long and subtle explanation which Mill in his day found it difficult to express with any sort of comprehension. The self-problem is abstruse and obscure even in our day of "fringes," and of feelings of "ifs, buts and ands." It is not to be wondered, therefore, that Mill's first handling of the subject should contain contradictions and short-comings of the grossest order; but the student who is alive to its full significance will find in Mill's elucidations the traces of a master psychologist.

The gist of Mill's theory, and particularly as applied to time, is, that we do not go outside of our ordinary sensations and their corresponding reproductions, as governed by the natural laws of production, association, and reproduction, in any of the processes of mind whatever; whether of personal identification, memory or perception of time relations.

This view differs from that of Herbart chiefly, in that the elements of sensation are not looked upon by Mill as "reals" between which there is direct attraction and repulsion, a metaphysical assumption for which there is to be found no scientific warrant; and it differs still more from the view of Volkmann in that no secondary feeling or sense of contention in the ordinary mental content, is needed; which secondary order of feeling is itself another metaphysical speculation without scientific justification or support.

JOHN STUART MILL sums up the case against the crucial point of his father as follows: "The distinction between a mere combination of ideas in thought, and one which reveals to us a combination of sensations as actually experienced, always returns on our hands as an ultimate postulate."[1]

But this can scarcely be conceived to be relevant to the position of his father, with whom a series of mental states actually occurring, that is, "a combination of sensations as actually experienced" *was* accepted as an ultimate postulate. The father's endeavor was, this *being* accepted or postulated, to show how the processes of memory worked *under* this postulate. With the elder Mill the ultimate postulate was that "series actually occurred"—out of these he developed the memory and the belief. His son first postulated the belief; the fault of which seems to be the same as postulating any other function, or faculty of the mind before inquiring if that faculty or function cannot be discovered to be a compound process. The "belief" can be deduced from the series, not the series from the "belief." J. S. Mill also went back to and emphasized the English school's theory of relations as taught by Brown.

HERBERT SPENCER'S evolutionary system of realism is well known; it conceives the entire physical world to be devel-

[1] Ibid. Appendix I, 416.

oped from ultimate homogeneous units, and all consciousness to be a corresponding development of mental units. The salient feature of Mr. Spencer's psychology is his theory of Relations. "The proximate components of mind are of two broadly contrasted kinds: Feelings, and the Relations between feelings. . . . Each feeling, as we here define it, is any portion of consciousness, which occupies a place sufficiently large to give it a perceivable individuality; which has its individuality marked off from adjacent portions of consciousness by qualitative contrasts; and which when introspectively contemplated, appears to be homogeneous . . . A relation between feelings is on the contrary, characterized by occupying no appreciable part of consciousness. Take away the terms which it unites, and it disappears along with them; having no independent place, no individuality of its own. It is true that under an ultimate analysis, what we call a relation proves to be itself a kind of feeling—the momentary feeling accompanying the transition from one conspicuous feeling to an adjacent conspicuous feeling. And it is true that notwithstanding its extreme brevity, its qualitative character is appreciable; for relations are distinguishable from one another, only by the unlikeness of the feelings which accompany the momentary transitions. Each relational feeling may, in fact, be regarded as one of those nervous shocks, which we suspect to be the units of composition of feelings; and though instantaneous, it is known of greater or less strength and as taking place with greater or less facility. But the contrasts between these relational feelings and what we ordinarily call feelings is so strong that we must class them apart."[1] Relations, then, with Mr. Spencer are an entirely disparate sense, as much as the time-sense of Czermak, or the time-feelings of Horwicz. "A succession of changes" Mr. Spencer declares to be "the subject matter of psychology; it is the business of psychology to determine the law of their order." Of particular importance for the time question is Mr. Spencer's fundamental conception of perceptions of likeness and unlikeness of relations of succession.

[1] Principles of Psychology (New York, 1877), I, 163.

"The requisite to the existence of a relation is the existence of two feelings between which it is the link. The requisite to the existence of two feelings is some difference. And therefore the requisite to the existence of a relation is the occurrence of a change, the passage from one apparently uniform state to another apparently uniform state, implying the momentary shock produced by the commencement of a new state."[1] "The ultimate relation therefore, is nothing more than a change in the state of consciousness; and we call it either a relation of unlikeness, or a relation of sequence, according as we think of the *contrast* between the antecedent and consequent states, or of their *order*."[2] Mr Spencer suffers much difficulty with his relations of likeness. "The two terms of a relation of likeness are the antecedent and consequent of what, in one sense, is *no change*; seeing that it leaves consciousness in the same condition as before." But as above, because "two states if not different can not exist as separate . . . accurately speaking, therefore, a relation of likeness consists of two relations of unlikeness which neutralize each other. It is a change from some relatively enduring state A to another state X (which represents the feeling we have while passing from one of the like things to the other) and a change from the transitory state X, to a second relatively enduring state A, which would be indistinguishable from the first state were it not divided from it by the state X" (p. 284). Surely here are contradictions as obvious as print can make them. Yet these are Mr. Spencer's theories of Relations, which he considers the fundamental principle of all reason and all intelligence,[3] including of course all problems of identity, memory and time-perception.

Mr. Spencer's manner of elucidating the latter is, however, more successful, and is perhaps more profound than that of

[1] Vol. II, p. 287. Query: If a 'shock of relation' intervened between the two like states, would not this suffice, by Mr. Spencer's own theory, for the two states to be known *as* separate and also as like? Again: *Why* may not consciousness be in two states at the same time? Have we any proof that an area of red and an area of blue may *not* be simultaneously in consciousness? Rather this is what apparently does take place.

[2] Ibid.

[3] Ibid, chapters on Reason and Intelligence.

any other writer. This, if his theory of relations be borne in mind, may be sufficiently indicated by saying that it develops from his standpoint of Relations, along the traditional lines of English association (especially of James Mill), perfected and enlarged in accordance with the doctrines of evolution.

S. H. HODGSON, in his "Philosophy of Reflection" (Vol. 1, p. 248-254) has produced a discussion, which deserves a place here, if for nothing more than to sample the loose, irresponsible sort of imagination regarding the subject, that not only gets printed, but also gets quoted. "What I find, when I look at consciousness at all is, that what I can not divest myself of, or not have in consciousness, if I have consciousness at all, is a sequence of different feelings. . . . The simultaneous perception of both sub-feelings, whether as parts of a co-existence or of a sequence, is the total feeling—the minimum of consciousness—and this minimum has duration. . . . Time duration, however, is inseparable from the minimum, notwithstanding that, in an isolated moment we could not tell which part of it came first, which last. . . . We do not require to know that the sub-feelings come in sequence, first one, then the other; nor to know what coming in sequence means. But we have in an artificially isolated minimum of consciousness, the rudiments of the perception of former and latter in time, in the sub-feeling that grows fainter, and the sub-feeling that grows stronger, and the change between them. . . . In the next place, I remark that the rudiments of memory are involved in the minimum of consciousness. The first beginnings of it appear in that minimum, just as the first beginnings of perception do. As each member of the change or difference which goes to compose that minimum is the rudiment of a single perception, so the priority of one member to the other, although both are given to consciousness in one empirical present moment, is the rudiment of memory. The fact that the minimum of consciousness is difference or change in feelings, is the explanation of memory as well as of single perceptions. A former and a latter are included in the minimum of consciousness; and this is what is meant by saying that all consciousness is in the form of *time*, or that time is the form of

feeling, the form of sensibility. . . . It is clear that the minimum of feeling contains two portions, a sub-feeling that goes and a sub-feeling that comes." Mr. Hodgson seems to mean by "having rudiments of perception," etc., that *alone* which he conceives to take place in a single momentary sequence; and by "knowing how these take place" to mean the long processes of his thought when he thinks *about* the rudimentary process; but why confuse the two so continually? To say that "a former and a latter are included in the minimum of consciousness" is in reality declaring that a former term of a sequence includes a latter term of that sequence.

E. R. CLAY, in his "The Alternative" (p. 167), also adds under title of the "Specious Present" another confusion to the problem. The gist of his view is as follows: "All the changes of place of a meteor seem to the beholder to be contained in the present. At the instant of the termination of such series, no part of the time measured by them seems to be past[1]." Supposing the meteor went on whirling about for an hour, a day, a year or two: there might continue to appear to the observer an unbroken streak of light around the heavens in the path of the meteor, yet would he never discover beside this simple case of visual after-image, certain sensations of motion "going on?" When he did discover the process of this going-on-series would "*all of this series seem to be contained in the present?*" The *continuing* after-image seems confounded by this author with a *remembrance* of the motion series; there is no more justification for confounding the *momentary* after-image with a *momentary* motion series than there would be for confounding a *week* of after-image with the eternal path of the hypothetical meteor.

M. GUYAU, in his "La Genése de l' Idée de Temps (Paris, 1890), from an entirely empirical standpoint, develops the idea of time out of our ideas of space. Every co-existent presentation which constitutes our idea of a series as such, is more or less a figurative presentation; *i. e.*, spatial. Both space and time he traces back to feelings of effort of motion. The will is the present; the desire is the future. M. Guyau

[1] Cited by Prof. James, I, 609.

fairly represents the present tendency of psychology in France.

The article on Psychology in the 9th edition of the *Encyclopædia Britannica*, by JAMES WARD, gives an admirable summary of the best current opinion on psychological matters, save perhaps with too much leaning toward the widely doubted theories of apperception put forth by Prof. Wundt.

Mr. Ward does not attempt metaphysically to go behind the data of psychology: "By pure Ego or Subject it is proposed to denote the simple fact that everything mental is referred to self" (p. 39). Of the origin of this self he says: "The body becomes in fact the earliest datum for our later conceptions of permanence and individuality" (p. 56). He adopts the Laws of Association as stated by Dr. Bain (p. 61) whose classification of the elements of the mind he also accepts, namely: sense, feeling, will (p. 40). This, with the following remark of Mr. Ward regarding the traditional discussion of perception *vs.* sensation, will make his general psychological standpoint sufficiently clear for our purpose: "It has been usual to say that perception implies both memory and imagination; but such a statement can be allowed only as long as these terms are vaguely used" (p. 61).

Approaching the subject of time Mr. Ward says: "Thus as the joint effect of obliviscence and reduplication we are provided with a flow of ideas distinct from the memory-train, and thereby with the material, already more or less organized for intellectual and volitional manipulation" (p. 62). That is for thought in general in distinction from actual remembrances. "Retentiveness is both a biological and a psychological fact; memory is exclusively the latter. In memory there is necessarily some contrast of past and present; in retentiveness nothing but the persistence of the old" (p. 47). "Memory includes recognition; recognition as such does not include memory. . . . But of the two characteristics of memory proper—(*a*) concreteness of circumstantiality, and (*b*) localization in the past—the latter is the most essential" (p. 63). With the content of memory or time-percepts we are not at present concerned; on how this content is localized in the past, Mr. Ward writes as follows: "To a being whose

presentations never passed through the transitions which ours undergo—first divested of the strength and vividness of impressions (original sensations), again reinvested with them and brought back from the faint world of ideas—the sharp contrasts of 'now' and 'then,' and all the manifold emotions they occasion, would be quite unknown. . . . Time-order, succession, antecedence and consequence, of course, there might be still; but in that sense of events as 'past and gone forever' . . there is much more than time-order. . . . We have not to ask how time itself comes to be; but assuming it to be, we ask how the individual comes to know it. . . . . The present, though a point of time, is still such that we can and do in that moment attend to a plurality of presentations, to which we might otherwise have attended severally in successive moments. Granting this implication of similarity and succession, we may, if we represent succession as a line, represent simultaneity as a second line at right-angles to the first; empty time—or time length without time breadth—we may say is a mere abstraction. Now it is with the former line that we have to do in treating of time as it is, and with the latter in treating of our intuition of time, where, just as in perspective representation of distance, we are confined to lines in a plane at right-angles to the actual line of depth. In a succession of events, say of sense impressions A, B, C, D, E. . . . the presence of B means the absence of A and of C; but the presentation of this succession (as a whole) involves the simultaneous presence, in some mode or other, of two or more of the presentations A, B, C, D. In presentation, as we have seen, all that corresponds to the difference of past, present and future, is in consciousness simultaneously. This truism, or paradox, that all we know of succession is but an interpretation of what is really simultaneous or co-existent, we may then concisely express by saying, that we are aware of time only through time-perspective, and experience shows it is a long step from a succession of presentations, to such presentations of succession. The first condition is, that we should have represented together presentations that were in the first instance attended to successively, and this we have both in the

persistence of primary memory-images, and in the simultaneous reproduction of longer and shorter portions of the memory-train. In a series thus secured there may be time-marks, though no time, and by these marks the series must be distinguished from other simultaneous series. To ask which is first among a number of simultaneous presentations is unmeaning; one might be logically prior to another, but in time they are together and priority is excluded. Nevertheless, after each distinct representation a, b, c, d, there probably follows, as has been supposed, some trace of that movement of attention of which we are aware in passing from one presentation to another. In our present reminiscence, we have, it must be allowed, little direct proof of this interposition; though there is strong indirect evidence of it in the tendency of the flow to follow the order in which the presentations were first attended to. With the movements themselves we are familiar enough, though the residua of such movements are not ordinarily conspicuous. These residua, then, are the temporal-signs, and together with the representations connected by them constitute the memory continuum. But temporal signs alone will not furnish all the pictorial exactions of the time perspective. They give us only a fixed series; but the working of obliviscence, by insuring a progressive variation in intensity and distinctness as we pass from one member of the series to the other, yields the effect which we call time-distance. By themselves, such variations would leave us liable to confound more vivid representations in distance, with fainter ones nearer the present, but from this mistake the temporal-signs save us; and as a matter of fact, when the memory-train is imperfect such mistakes continually occur. On the other hand, where these variations are slight and imperceptible, though the memory continuum preserves the order of events intact, we have still no such distinct appreciation of comparative distance in time, as we have nearer the present when these perspective effects are considerable." (pp. 64, 65.)

Two points are to be observed in the above: First, Mr. Ward does not go outside of his three classes of mental elements: Sense, Feeling and Will; does not posit any hypo-

thetical special time-sense, feeling, intuition, concept, self or super-consciousness whatever; and second, he conceives every time-concept to be a complex co-existent state, and not a series of states.

Prof. WILLIAM JAMES devotes a chapter of his vigorous and suggestive Principles of Psychology to the perception of time. In general philosophical standpoint he confesses himself a spiritualist, but he is far from abhorring mechanism in memory and time-perception. He says "objects fade out of consciousness slowly. If the present thought is of A, B, C, D, E, F, G, the next one will be of B, C, D, E, F, G, H, and the one after that of C, D, E, F, G, H, I, the lingerings of the past dropping successively away, and the incomings of the future making up the loss. These lingerings of old objects, these incomings of new, are the germs of memory and expectation, the retrospective, and the prospective sense of time. They give that continuity to consciousness without which it could not be called a stream." (I, p. 606.) "The strict present . . . is in fact, an altogether ideal abstraction. Reflection leads us to the conclusion that it *must* exist, but that it *does* exist can never be a fact of our immediate experience." Prof. James then introduces Mr. Clay's "Specious Present" given above and proceeds—"In short the practically cognized present is no knife edge, but a saddle-back with a certain breadth of its own on which we sit perched, and from which we look in two directions into time. The unit of composition of our perception of time is *a duration*, with a bow and a stern, as it were, a rearward and a forward-looking end. It is only as parts of this *duration-block*, that the relation of *succession* of one end to the other is perceived. We do not first feel one end and then feel the other after it, and from the perception of the succession infer an interval of time between, but we seem to feel the interval of time as a whole, with its two ends imbedded in it. The experience is from the outset a synthetic datum, not a simple one; and to sensible perception its elements are inseparable, although attention looking back may easily decompose the experience and distinguish its beginning from its end. (pp. 608–610.) There is a certain emotional *feeling* accompanying the intervals of

time" (p. 618). "The feeling of time and accent in music, of rhythm, is quite independent of that of melody." (p. 619.) "All continuous sensations are *named* [counted] in beats. We notice that a certain finite 'more' of them is passing or already past . . . the sensation is the measuring tape, the perception the dividing engine which stamps its length. As we listen to a steady sound, we *take it in* in discreet pulses of recognition, calling it successively the same! the same! the same!" "After a small number of beats our impression of the amount becomes quite vague. Our only way of knowing it accurately is by counting, or noticing the clock, or through some other symbolic conception. When the times exceed hours or days, the conception is absolutely symbolic. No one has anything like a *perception* of the greater length of the time between now and the first century than that between now and the tenth. There is properly no comparative time *intuition* in these cases at all. It is but dates and events *representing* time." (p. 622). "The feeling of past is a present feeling." "*A succession of feelings, in and of itself, is not a feeling of succession. And since, to our successive feelings, a feeling of their own succession is added, that must be treated as an additional fact requiring its own special elucidation*" (p. 628). He here introduces approvingly the time-theory of Mr. Ward given above. Then he proceeds "and since we saw a while ago that our maximum distinct *intuition* of duration [specious present] hardly covers more than a dozen seconds, we must suppose that *this amount of duration is pictured fairly steadily in each passing instant of consciousness* by virtue of some fairly constant feature in the brain process to which the consciousness is tied. *This feature of the brain process, whatever it be, must be the cause of our perceiving the fact of time at all.*" "Please observe, however, that the reproduction of an event *after* it has once completely dropped out of the rear ward end of the specious present is an entirely different psychic fact from its direct perception in the specious present as a thing immediately past. A creature might be entirely devoid of *reproductive* memory and yet have the time-sense, but the latter would be limited in his case, to the few seconds immediately passing by. Thus

memory gets strewn with *dated* things dated in the sense of being before or after each other. The date of a thing is a mere relation of *before* or *after* the present thing, or some past or future thing. Some things we date simply by mentally tossing them into the past or future direction. So in space we think of England as simply to the eastward, etc." "But the *original paragon and prototype* of all conceived times is the specious present, the short duration of which we are immediately and incessantly sensible." (pp. 630 sq.) "*Now to what element in the brain-process may this sensibility be due?* It cannot, as we have seen, be due to the mere duration itself of the process; it must be due to an element present at every moment of the process, and this element must bear the same inscrutable sort of relation to its correlative feeling which all other elements of neural activity bear to their psychic products, be the latter what they may" (p. 632). "To state it in neural terms *there is at every moment a cumulation of brain processes overlapping each other, of which the fainter ones are the dying phases of processes which but shortly previous were active in a maximal degree. The amount of the overlapping determines the feeling of the duration occupied. What events shall appear to occupy the duration depends on just what processes the overlapping processes are.*" (p. 635.) "*Why* such an intuition should result from such a combination of brain-processes I do not pretend to say. All I aim at is to state the most *elemental* form of the psycho-physical conjunction." (p. 636.) "Longer times are conceived by adding, shorter ones by dividing portions of this vaguely bounded unit [specious present] and are habitually thought by us symbolically. Kant's notion of an *intuition* of objective time as an infinite necessary continuum has nothing to support it." (p. 642.)

Prof. James then passes to the consideration of memory: "*It is the knowledge* of an event, or fact . . . with the additional consciousness that we have thought or expressed it before." "No memory is involved in the mere fact of recurrence. The successive editions of a feeling are so many independent events, each snug in its own skin . . . . . Memory requires more than mere dating of a fact in the past.

It must be dated in *my* past" . . . . "A general feeling of the past direction in time, then, a particular date conceived as lying along that direction, and defined by its name or phenomenal contents, an event imagined as located therein, and owned as part of my experience—such are the elements of every act of memory" (p. 650). "Memory is then the feeling of belief in a peculiar complex object; but all the elements of this object may be known to other states of belief; nor is there in the particular combination of them as they appear in memory anything so peculiar as to lead us to oppose the latter to other sorts of thought as something altogether *sui generis* needing a special faculty to account for it. When later we come to our chapter on belief we shall see that any represented object which is connected either mediately or immediately, with our present sensations or emotional activities tends to be believed in as a reality. The sense of a peculiar active relation in it to ourselves is what gives to an object the characteristic quality of reality, and a merely imagined past event differs from a recollected one only in the absence of this peculiar feeling relation. The electric current, so to speak, between it and our present self does not close. But in their other determination the recollected past and the imaginary past may be much the same. In other words, there is nothing unique in the *object* of memory, and no special faculty is needed to account for its formation." (p. 652).

Thus Prof. James' time-sense is a separate disparate feeling, like that of Horwicz, Czermak, *et al.* But do we have any such extra feelings? How could any such extra feeling be other than just another feeling as separate as all the rest? How could it join these overlapped feelings any more than they could join themselves—or than merely successive feelings could join themselves? Who is it that sits in the saddle-back and looks both ways? How does this Jack-in-the-saddle *know* which way to look; *which way* the overlapping feelings are overlapped? which way they *are* moving? *How does this feeling know or constitute anything regarding time direction, more or other than the passing sequence constitutes of itself?*

Casting an eye backward, we can but be struck by the wide variety of explanations offered for the time-mystery. Time has been called an act of mind, of reason, of perception, of intuition, of sense, of memory, of will, of all possible compounds and compositions to be made up from all of them. It has been deemed a General Sense accompanying all mental content in a manner similar to that conceived of pain and pleasure. It has been assigned as a separate, special, disparate sense, to nigh a dozen kinds of "feeling," some familiar, some strangely invented for the difficulty. It has been explained by "relations," by "ear-marks," by "signs," by "remnants," by "struggles" and by "strifes," by "luminous trains," by "blocks of specious-present," by "apperception." It has been declared *à priori*, innate, intuitive, empirical, mechanical. It has been deduced from within and from without, from heaven, and from earth, and from several things difficult to imagine as of either. Finally, one high modern authority has discovered that time is the long-sought-for fourth dimension of space. In one particular alone is there uniformity; with the exception of Condillac, James Mill, Herbart, and Horwicz, *all* have looked upon the mystery unqualifiedly and unmistakably as *a single state*. Among the best modern authorities the presentation of time-order and relation may be said to have worked itself out to what, though expressly declared to be otherwise, is really a sort of compromise position between a simple state and a simple *process*; to be looked upon as a certain definite, particular, complex, though co-existent *arrangement*. It is the most striking feature of the whole time investigation, that of all the philosophers and psychologists who have touched upon the problem, only *two* of the whole number, Condillac obscurely, and James Mill definitely, have solved the mystery by *letting the sequences themselves be the ultimate mystery*—by letting their process, as process and of itself, show forth its own explanation. It would not be surprising if such diversity of failures should be explained by such unity of neglect of careful and exhaustive consideration of this seemingly most natural and certainly most simple source of explanation. A further examination of this point will constitute a later section of this paper.

II.—EXPERIMENTAL INVESTIGATIONS.

The earliest empirical observation which I find recorded is otherwise unimportant. The Scotch philosopher, THOMAS REID, says: "I have found by some experiments that a man may beat seconds for one minute without varying above one second in the whole sixty; and I doubt not but by long practice he might do it still more accurately. From this I think it follows that the sixtieth part of a second of time is discernible by the human mind."[1]

As the philosophy of time has usually followed that of space, so experiments upon it were an outgrowth of those on space.

In 1852 E. H. WEBER published his famous discoveries regarding our appreciation of distance and direction on the surface of the body. That this appreciation varied without proportion to our sensitiveness to pressure or temperature for the same regions, Weber held as proof that our space perceptions were made by a strictly disparate sense, which, coining the phrase, he called the space-sense.[2]

JOH. NEP. CZERMAK, professor of physiology at Leipzig, perceived that these views necessarily involved our conceptions of time; he was, therefore, led to believe in still another disparate sense, which he named the time-sense.[3] As this invariably accompanied all other sensations, he termed it a general sense in distinction from the special senses. Unable to carry out his intentions he recommended the following to be determined: (1) The shortest interval perceivable in each of the separate senses. (2) How the same interval is interpreted by the different senses. (3) How like rates of motion are interpreted by various regions of the skin, determined by Weber to be of different spatial sensibility. (4) The least change

[1] Complete Works (Edinburgh, 1872), p. 350.

[2] "Ueber d. Raumsinn u. d. Empfindungskreise in d. Haut u. d. Auge." D. könig. Säch. Gesell. d. Wiss. zu Leipzig. Sittung 18, Dec., 1852. Math. Phys. Classe, 1-4, Jahrgang, 1849-52, S. 85.

[3] "Ideen zu einer Lehre von Zeitsinn." Complete works (Leipzig, 1879); also Wiener akadem. Sitzungsberichte, 1857; Nat. Cl. Bd. XXIV, p. 231; and Moleschott's Untersuch., Bd. V, Heft. 1, 1858.

in rate of motion perceivable for various dermal regions. (5) The relations between rates of motion and changes in the angle of convergence of the eyes. (6) To investigate the formula $V = \frac{r}{t}$ for points of the retina or skin having different spatial sensibility (V, rate of motion; r, space; t, time). Some of the suggestions of Czermak, by reason of his high standing as a physiologist, were immediately undertaken. Nearly at the same time Vierordt, assisted by Höring and Camerer at Tübingen, and Mach at Graz, began the work.[1]

A. HÖRING. *Versuche über das Unterscheidungsvermögen des Hörsinnes für die Zeitgrössen.* Inaug. Dissertation, Tübingen, 1864.

Experiments: Eight beats were given by a Mälzel metronome; then without appreciable loss of time the weight was moved up or down or left as before. Subject without having seen the pendulum, was to judge if the second set of beats be "longer," "shorter," or "same" in comparison with the first set; the cases in which the subject was unable to decide were thrown out of the records. The experiments were made on Höring by Prof. Vierordt. A total of 1,885 sets of beats were taken, using intervals from .306 to 1.428 in length;[2] an average of 10 trials was made for each interval, and 82 was the maximum for any interval. The experiments were delayed through a half year to avoid fatigue and any unusual influences. The method used was that of Right and Wrong Cases.

Results: A constant inclination to misjudge the second or compared set of intervals; intervals of .454–1.428 were estimated to be shorter, and those of .306 to .365 longer than they were. Sensibility or discrimination decreases with lengthening of the interval.

Comment: No ordinary metronome is sufficiently accurate for this purpose; as it runs down, the strength of tick and length of beat varies; alternate beats can not be maintained of equal length; the weight can not be accurately adjusted without varying the interval between the first and second set of

[1] It has seemed best in what follows to vary from the continuous narrative form of presentation toward that employed in the review department of the JOURNAL OF PSYCHOLOGY. Abstracts of contributions to the subject will be distinguished from my own comment by a different typography.

[2] In all cases not otherwise specified the unit is a second.

beats, which is important. Too few trials were made on each interval to warrant the conclusion that the results were more than mathematically fortuitous. Only one person was experimented upon, while contradictory individual differences are the rule. The results regarding sensibility have been confirmed; those as to the constant error have been variously confirmed and contradicted.

WILHELM CAMERER. *Versuche über den zeitlichen Verlauf der Willensbewegung.* Inaug. Diss. Tübingen, 1866. Zeitschrift für Biologie, Bd. XVII; S. 17.

Results: It was found that movements made in 1.5 could be adjusted to cover the distances tested with greatest accuracy; the hand attempting to measure off a given distance in a shorter or longer time, respectively, over-ran or fell short of the proper distance.

ERNST MACH. *Untersuchen über den Zeitsinn des Ohres.* Moleschott's Untersuchungen, 1866, Bd. X; S. 181; and Sitz. d. Wiener Akad. d. Wiss. Math. Kl. Bd. 51; Abth. 2, 1865.

Standpoint: Herbartian; and the time-sense looked upon as disparate. *Purpose:* To test Weber's law. *Apparatus:* Finely adjusted metronome, beating alternately long and short beats or the reverse. For very short intervals a spring was used, snapping upon teeth cut at iambic intervals upon the edge of a wheel which was revolved by hand mechanism. For very long intervals the assistant held a watch to the ear and beat with a hammer. *The method* used was Least Perceivable Difference. *Experiments* extended from year 1860 to 1865; it is indefinitely stated that "a great number of trials" were made upon six persons, using intervals from .016 upward. *Results:* Weber's law not valid. Sensibility inverse to length of interval, and varies daily; greatest sensibility shown for intervals of about .375. Threshold (for ear) about .016, and less for ear than for any other of the senses. When iambic intervals are repeated many times in same direction, we lose power to distinguish the longer from the shorter beat; this effect is counteracted by alternating the directions.

Comment: Turning a wheel, and beating with a hammer by the hand, can not give accurate results. The number of trials is not stated, and figures are given for but a few of the intervals tested. The paper is too indefinite to justify its results. The threshold found is far higher than subsequent experiments have established.

KARL VIERORDT. *Der Zeitsinn.* Tübingen, 1868.

Standpoint: Time perception is rather an act of judgment than of sense; "the soul is needed to explain many things." *Purpose:* To investigate the time-sense in general and the constant error in particular. *Apparatus:* Same as used by Camerer and Höring; also kymograph and a writing lever, one arm of which wrote directly on the drum, the other arm being worked by the finger. *Method:* Chiefly that of Right and Wrong Cases; asserts it was used in his laboratory as early as 1853. *Experiments:* (1) Two ticks of the metronome, self-recorded on the kymograph, were given by the assistant; the subject then pressed his finger to mark off on the drum an interval immediately following and equal to that given by the metronome. (2) Another set of experiments was like the above save that a pause, whose length was determined by the subject, was made between the normal or metronome interval and its reproduction. (3) Eight successive beats were given from the metronome, the subject immediately recording a like number of judgments. (4) Beats were given by touch on the back of the left-hand with a small steel point; two beats, pause, followed by single reproduction with right-hand as in (2); eyes and ears closed. (5) Subject chose any interval at random, and tried to record three beats inclosing two equal intervals. (6) Four beats in place of three, a pause being introduced between first and last interval as in (2). (7) Interval chosen at will as in (5), then reproduced from 4 to 120 times (generally about 4 reproductions). (8) Seven classes of judgments were made, namely: Very long, long, tolerably long, indifferent, tolerably short, short, very short; attendant then gave an interval repeating it 10 times, and the subject assigned it to one of the above rubrics. (9) Estimation of longer intervals, *i. e.*, from 5 min. to an hour. (10) Experiments with intervals of sight.

Results: "For all categories of time from seconds to years, the same law holds good, *i. e.*, the relatively short intervals are lengthened by judgment and the relatively long intervals are shortened." Vierordt holds his experiments sufficient to determine the law definitely, though the constant error may vary for different persons, times of experiment, senses, and other conditions. He tested intervals usually ranging from .25 to about 8. The indifference point for himself was: ear, 3 — 3.5; eye, 2.2 — 2.5, for H. (ear) 1.4; for N. 1.5. The indifference point fell on a longer interval when a pause was made between norm and reproduction. Morning hours, and good physical and mental condition were favorable to more accurate estimates of longer intervals; intense mental strain led to under-valuation. Sensibility was found greatest at about 1 to 1.5, and was more exact when as in (1) no pause

was made between norm and judgment. Judgment was more accurate after 8 beats as in (3), than when the norm was heard but once. Weber's law does not hold. Vierordt suggests that contrasts affect judgment; that after several short beats, a longer interval seems unduly long.

Comment: Only three persons were experimented upon; most of the results are from two individuals; 2147 single judgments were made in all; these spread over the large number of intervals tested, under several different methods, and upon two men, leaves far too few trials on any one interval, for conclusive results. The same criticism of metronomes applies here as to Höring. The results are valuable as far as they go, but must be deemed inconclusive even on the points taken up.

WILHELM WUNDT. *Ueber psychologische Methoden.* Wundt's Phil. Studien. Bd. I. 1882; S. 1.

Wundt here complains that Vierordt's experiments unwarrantably complicate the time judgments with voluntary muscular movements; that is those used in reproduction; also that the indefinite pause introduced between the norm and the reproduction in many of the experiments causes an indefinite break in the rhythm, which must disturb judgment with great irregularity. Wundt claims that the time-sense is so extremely delicate that the apparatus used by Vierordt as well as his method of Right and Wrong Cases, can give no reliable results. Wundt recommends his own method of Least Perceivable Difference.

JULIUS KOLLERT. *Untersuchungen über den Zeitsinn.* Wundt's Phil. Studien. Bd. I. 1882; S. 78.

This work was done under the direction of Prof. Wundt at Leipzig. *Purpose:* To reinvestigate the Constant Error and Sensibility, with more accurate apparatus and method, and particularly without involving the time-reaction of reproduction. *Apparatus:* Two finely adjusted metronomes, governed by electric current and magnets. *Experiment:* In all cases the norm was given by two beats from one metronome, then, after a pause invariably equal to the norm, another interval was given by two beats from the other metronome; these two intervals to be judged according to Wundt's method of Least Perceivable Difference, that is, the compared interval was first made equal to the norm, then gradually lengthened till it was just perceived to be longer than the norm; next the compared interval was made marked-

ly longer then the norm, then gradually shorter till just indistinguishable from the norm; the average was then taken of these two judgments just perceivably longer than the norm. An average is similarly determined for the two judgments just perceivably shorter than the norm. The Constant Error is then calculated by averaging the just perceivable shorter and longer judgments so determined. The norms used were .4, .5, .7, .8, 1.0, 1.2, and 1.836. Seven men were experimented on, and a total of 175 single determinations of the Constant Error made.

Results: 42 or about 25% of the 175 determinations were classed apart as "anomalies" because in these the Constant Error appeared a maximum at the point where in the "regular" cases it appeared a minimum. The remaining 133 "regular" trials confirmed Vierordt's Law that for relatively long intervals the Constant Error is negative, and for relatively short ones positive; but the Indifference Point as averaged from the seven persons was .755 in place of 3. — 3.5 as given by that experimenter. The 42 anomalous trials were mostly overjudged. Sensibility was greatest at the Indifference Point, diminished rapidly with shortening intervals, and more slowly with lengthening intervals. No explanation was found for the "anomalies."

Comment: Metronomes have never proved sufficiently accurate or reliable for time experiments; to use two metronomes together is objectionable as the difference of their sound disturbs judgment. It is doubtful if Wundt's method of Least Perceivable Difference as used by Kollert is free from objections, since the judgment of the subject is always biased; he knows beforehand the direction and nearly the degree in which his judgment is to be made, *i. e.* which way the pendulum weight is to be moved and about how much, and soon *expects* to perceive no difference or the reverse. There seems no good reason for having culled out the 42 anomalies; that they were different from what was expected is no ground for classifying them apart. The remaining 133 trials, when divided among seven persons, and again among the seven intervals used, leaves but an average of about 3 trials for each interval per man, which, in view of the great variation the time problem is now known to be susceptible to, is altogether insufficient to prove the results to be more than mathematically fortuitous. Kollert lumps his results leaving us entirely in the dark as to just how the trials were

divided among men and intervals with reference to specific results. This is inexcusable and, besides detracting largely from the value of his own conclusions, renders impossible any revision of them by a closer analysis of the facts. Care does not seem to have been taken that the subject should remain ignorant both of the course and of the purpose of the experiments; this is important, as otherwise subjective influences are inevitable to a degree that renders the results comparatively worthless. On the whole Kollert's determinations are unsatisfactory and of doubtful value. They show intervals between .755 and 1.836 to be shortened while Vierordt found the same to be lengthened.

KARL VIERORDT. *Psychophysiche Bemerkungen.* Zeitschrift für Biologie, Bd. 18, 1882; S. 397.

Vierordt here briefly defends his work against the attacks of Wundt and Kollert; shows the reaction-time of reproduction is too short to vitiate his results, and that in most of his experiments it was neutralized and not included at all. The pause between norm and reproduction made in some of the rubrics, he thinks most accurately adjusts itself when left to the inclination of the subject. In turn he criticises rather bitterly the method of Wundt, raising many of the objections we have stated above against Kollert.

VOLKMAR ESTEL. *Neue Versuche über den Zeitsinn.* Wundt's Phil. Studien, II. 1884; 37.

This work was also from Prof. Wundt's Laboratory. *Purpose:* To extend the investigations of Kollert, to the longest intervals that can be judged as a whole, and to settle the dispute with Vierordt as to the effect of a pause between norm and comparison. *Apparatus:* New electric machine designed by Prof. Wundt; has horizontal metal wheel graduated on the edge; revolved by weight. Electric connections made at proper arcs of the revolving wheel regulate the desired lengths of norm, pause and comparison intervals; the stroke was made by electric hammer, during some of the experiments, on a bell, during others on an iron anvil. *Method:* Least Perceivable Difference as described of Kollert. *Experiments:* Divided into two sets, one without and the other with a pause, equal to norm, between norm and comparison interval. The intervals investigated were about the same for both sets and ranged from 1.5 to 8. The longer intervals were practised over several times, till they seemed familiar,

and then judged; the shorter intervals, as with all of Kollert's, were judged, each after a single hearing. Ten persons were experimented on, through a range of 18 intervals, with a total of 96 trials in the first set, and 293 trials in the second set.

Results: No time difference appeared between use of stroke of bell and stroke of anvil. Twenty-seven of the ninety-six trials in the first set, and 182 of the 293 in the second set, were culled out as anomalous, on the ground that "purely psychic" phenomena betrayed themselves in these; claimed by Estel to be due to "contrast," that is—all these anomalies were asserted to have occurred in the later experiments of each day, and to vary according as the intervals used during the first part of the day were longer or shorter than those of the later part. Estel stated the Law of Contrasts to be that the hearing of any interval makes a subsequent shorter or longer interval to be judged respectively longer or shorter than it really is. The other important result claimed by Estel was, that while all intervals longer than Kollert's indifference point of .755 "were under-estimated, yet the increase of the Constant Error was not regularly progressive with the lengthening of the interval, but rhythmic; relatively minimal values were asserted to appear at all multiples of the said indifference interval, *i.e* nearly at 1.5, 2.25, 3, 3.75, and 4.5." Sensibility also was rhythmically inverse to the constant error. Weber's Law was declared not to hold. Wundt and Estel incline to the belief that the multiple indifference point is governed by the pendulum-swing of the leg.

Comment: After carefully studying the tables of Estel, we agree with the strictures of Fechner (below) upon the demonstrations of a periodic course of the Constant Error. From the nature of the case irregularities are to be expected, and the assertion that these variations were in any sense rhythmic multiples of the indifference point seems to us entirely unfounded and forced. Also the Law of Contrasts, though perhaps true under very different conditions of quite other significance, seems quite unsupported by the data presented; at least, sufficient of the protocol should have been given to establish the order of the length of intervals used for each day's work. As it is, nothing appears upon which a revision of the facts can be based definitely to disprove Estel's claim—much less to support it.

As a whole the work of Estel appears not only inconclusive, but unscientific; too few trials were made in

proportion to the great variability of the results; only 389 tests were made in all, these divided among ten persons and eighteen intervals each, leave an average of but about two trials for each interval per individual; this is insufficient, particularly when as in the major rubric 209 out of 389 tests are classed apart as "anomalous." Again the "subjective" conditions were not sufficiently guarded. The controversy with Vierordt, under which the work was undertaken was spirited and unfortunate for unbiased psychological judgments; yet no care seems to have been taken to provide subjects undoubtedly free from the subtle involuntary prepossessions, which are so difficult to exclude in all psychological investigations. For such results to be of any definite value, a sufficient number of persons must be experimented upon who know neither the purpose nor the results of their judgments—this in order to establish the testimony beyond even any possible involuntary prejudice. Finally it seems almost incredible in the face of the contradictory evidence of Mach, Höring and Vierordt, and solely upon the meagre and much criticised results of Kollert, reinforced alone by the yet entirely problematical "leg-swing" theory,[1] that Estel should have *assumed* the fundamental Indifference Point upon which he based his entire periodic deductions, without adequate experiment for any of his ten subjects and absolutely with none at all covering that important interval for seven out of the total ten persons. Such neglect can be more easily explained by subjective prepossessions for theories than the results can be admitted to the rank of scientific facts.

G. THEO. FECHNER. *Ueber die Frage des Weber'schen Gesetzes und Periodicitätsgesetzes im Gebiet des Zeitsinns.* Ab. d. k. S. G. d. Wis. XIII, S. 3.

This paper subjects Estel's work to long and minute criticism, finally characterizing it as unreliable and false. The variations claimed by Estel as rhythmic, Fechner shows to lie entirely within the probabilities of accidental irregularity. Fechner also considers that nothing is to be dis-

[1] Martin Trautscholdt, in W. and E. Weber, Mechanik d. Mensch. Gewerkzeuge, pp. 77-254; Wundt's Phil. Studien I, 213 (249); Ibid. II, 286, 250.

covered irreconcilable with Weber's Law. Such high authority would have greater weight were the spirit displayed here less controversial, and less enthusiastic for the support of Weber's Law.

VOLKMAR ESTEL. *Ueber die Frage des Weber'schen Gesetzes und Periodicitätsgesetzes im Gebiet des Zeitsinns.* In Wundt's Phil. Studien, II, 1884; S. 475.

Estel makes a weak reply to Fechner's attack. In answer to a request for the precise order of each day's experiments, Estel says the results were unexpected, and the protocol had been designed for other ends, and therefore data could not be given. He excuses the small number of his tests by declaring that he had looked upon them only as indicative, and needing confirmation—that he made as many and on as many persons as "he had time for." As to the charge that he had brought out his results to suit his own preconceptions, he declares they were entirely unsuspected until after the experiments had been performed. His counter criticism against Fechner's deductions from his (Estel's) work in support of Weber's Law is effective.

MAX. MEHNER. *Zur Lehre vom Zeitsinn.* Wundt's Studien, II, 1884, 546.

Purpose: The severe criticisms of Fechner compel a reinvestigation of the work of Kollert and Estel. *Apparatus* and *Method:* The same as Estel's. *Experiments:* The order of each day's work was arranged to be free of all influences of contrasts. No pause was ever permitted between norm and comparison intervals. Judgment was always made after each hearing of the two intervals. Ten determinations were made for each length of interval used; twenty-eight intervals were tested ranging from .7 to 12.1. Mehner was himself subject for all experiments made.

Results: Four Indifference Points were found, namely, .71, 2.15, 3.55 and 5. All the *odd* multiples of the lowest Indifference Point, .71, were shown to be points of minimal worth of constant error, while *even* multiples showed maximal worth. All intervals between .71 and 5 were declared to be under-estimated; all from 5 to 12.1 and "probably far above" to be over-estimated. Sensibility was also a function of the odd multiples of the Indifference Point .71, (though inversely to the constant error) up to 7.1 above which it remained approximately constant; it was greatest at 2.15. Weber's Law did not hold below 7.1, *i. e.* so long as sensibility is rhythmic, but was approximately valid above 7.1, *i. e.* where sensibility is constant. He attributes individual differences and the

great disparity of results obtained by different experimenters mainly to the insufficient and varying amounts of practice which they had in estimating time intervals; he thinks the effect of practice is to lessen the constant error. Straining of the attention makes the interval seem longer; the experienced subject judges with less strain, therefore makes a smaller error; also familiar intervals being judged without a strain are shortened, while the longer ones, requiring great attention, are lengthened. Fatigue and low condition, mental or physical, require greater attention and therefore lengthen the interval; all this accords with and explains his results. Upon these grounds he thinks the results of Estel and others may be reconciled with his own work and with his theory of odd multiple periods, or expressed differently he thinks most of the results previous to his own to be of comparatively little worth, as their experimenters had not attained sufficient experience and skill to bring their judgments up to a non-fortuitous or non-variable standard. Mehner found 12.1 to be the longest interval he could judge without division, instead of the limit of 5—6 determined by Estel; he also attributes this to his greater experience. Mehner determined, contrary to the expectations of Fechner, that it made no difference in the result whether, in comparing the intervals, the long or the short interval preceded the other. He found Estel's Law of Contrasts was without validity for his judgments, where the norm was always heard only once, or at most only a few times; and he even inclines to think that were the norm heard many times and deeply impressed upon the subject, the results would be opposite to Estel's Law, for example, were the norm a short interval, a tendency to preserve this accustomed length would hold over and tend to make a new, subsequent, longer interval seem unduly short. He inclines to favor the method of Right and Wrong Cases as the most accurate and direct. Mehner attributes the alleged phenomenon of Periodicity to a universal rhythmic law, towards which the membering or compounding of all our presentations and mental content tends in general.

Comment: Mehner's experiments were conducted upon a single subject, and that person himself; they could not therefore be held to be general, or even valid for most individuals, until corroborated by many other experiments; also, for this reason they suffer greatly from the liability of subjective prepossessions, as we have explained in the case of Estel. Otherwise his work seems to have been conducted with particular care, and the number of his tests to have been suffi-

cient for establishing the general tendencies peculiar to a single individual. His deductions from these results regarding Periodicity seem, however, as forced and far-fetched as those of Estel, with which they conflict, and which have been severely criticized by Fechner. Re-examining Mehner's tables we believe his Law of Periodicity to be unwarranted by his own figures; there are few columns of figures in which a prepossessed imagination cannot discover some sort of approximate periodicity of equal validity as a "law" with that of Estel or Mehner. Regarding Mehner's opinion that experience, practice and attention explain all the discrepancies in the results of time-experiments, there is so far no adequate information as to what the tendencies of any of these influences are; several investigations regarding mental fatigue, as those of Glass, Cattell, and others in the Physiological Laboratory of this University, fail to support Mehner's view.

G. THEO. FECHNER. *In Sachen des Zeitsinnes und der Methode der richtigen und falschen Fälle, gegen Estel und Lorenz.* Wundt's Studien, III, (1884), 1.

Still further criticism is here raised against Estel and Mehner; though Fechner devotes more space to Estel, he seems to hold even weightier objection to the results of Mehner; he thinks the probability of any Law of Periodicity to be negatived by the fact that the law claimed by one contradicts that of the other.

RICHARD GLASS. *Kritisches und Experimentelles über den Zeitsinn.* Wundt's Studien, IV, (1887), 423.

Purpose: Glass assisted Mehner in most of his experiments; his testimony regarding them is therefore of value; he subjects Mehner's figures to a searching scrutiny, and comes to a like conclusion with Fechner; he thinks a proper interpretation of the tables of Mehner even contradicts the Law of Periodicity deduced from them by their author. Glass, therefore, proposes to give the entire matter experimental revision. *Method:* The Method of Average Error is now chosen for the first time in Wundt's Laboratory. *Apparatus:* same as that used by Estel and Mehner, so modified as to be instantly stopped by the operator. *Experiments:* All were made with single norm and single reproductions, and without pause between norm and reproduction. The subject recorded his reproductions or judgments directly by pressing a lever which stopped the revolution of the

wheel; the interval thus recorded was then read from the graduated arc of the wheel. One hundred trials were made on each interval tested; the Constant Error was averaged from these; the intervals asserted by Mehner to be periodic, were those chiefly investigated. Glass was the sole subject for all his work.

Results: Table I comprises 100 trials each, upon twenty-three intervals ranging from .7 to 15.; for all these the Constant Error was negative, with the exception of .7, for which it was slightly positive. Neither Estel's nor Mehner's Periodicity held good, but a new law, based upon multiples of 1.25 was thought to be observed. Therefore, a greater number of intervals, 42 in all, differing less from each other, but covering the same range as the others, was next tested, with 100 trials each. These form Table II, which shows the Constant Error positive for 1.8 and under; negative for 5.4 and over, and variable between 1.8 and 5.4. Periodicity was again thought to be observed on intervals still 1.25 *apart*, but not falling on the *same* intervals as previously. Hence, the experiments given in Table III were undertaken, comprising 100 trials each, on intervals regularly .25 different in length, through the range .75—9, making 34 intervals in all. These showed Constant Error positive for 2 and under, negative for 4 and over; inconstant from 2 to 4. If for Table III, however, a reaction-time of .05 be deducted for the time occupied in stopping the instrument, the Constant Error would be negative throughout except for the lowest interval, .75. Glass concludes that the Constant Error is normally negative for all intervals. Again, all multiples of 1.25 appear as points of relatively minimum values for the Constant Error. The experiments of Table IV were then undertaken to discover the variations in judgment of the same interval from day to day. Only *one* interval and *two* successive days were tested. Glass claims the results "agree pretty well" with each other, and with those for the same interval in Table III. [According to his figures, however, the value from Table I is about 300 per cent. longer; from Table II about 200 per cent. longer; and from Table III about 60 per cent. shorter than those of Table IV.] He, therefore, concludes that in general the variations in his three main tables are not greater than those to be expected from day to day; and in view of their general agreement, so demonstrated, he asserts a new Law of Periodicity striking the multiples of 1.25, though the interval of 1.25 is not itself a point of least value of the Constant Error.

Comment: All the objections which have been made against Mehner for testing his experiments solely upon himself are

applicable with greater force against Glass; for, having assisted Mehner in the previous experiments, he was more liable to have formed prepossessing conceptions. Regarding this third Law of Periodicity, which contradicts the two previously published, a close examination of the tables seems to confirm the views of Fechner, twice maintained by him against the probability of such a law. The insufficiency of the evidence with the fact that each experimenter found a different law entirely irreconcilable with the others, and coupled with the tendency already mentioned, for all columns of figures to present variations more or less delusively or fortuitously rhythmic, ought to dispose of this subject until some very conclusive results shall newly establish such a Periodicity as a fact.

LEWIS T. STEVENS. *On the Time-Sense.* Mind. Vol. XI. No. 43.

These experiments were chiefly performed under the direction of Pres. G. Stanley Hall, at Johns Hopkins University, and were confirmed by other experiments under Prof. Henry P. Bowditch of the Harvard Medical School. *Purpose:* To investigate the Constant Error with both norm and reproduction many times successively repeated. *Apparatus:* Beats were given by a metronome, and recorded by electric circuit on a Marey kymograph; the key of the circuit was extremely delicate, and worked by the finger with scarcely perceptible exertion; the intervals were measured on the drum by a tuning-fork of known vibration rate. *Method:* Average Error. *Experiments:* "The individual under experiment tapped the lever synchronously with the beats of a metronome. When he had become perfectly familiar with the given interval, the drum of the kymograph was set in motion, and the first round of the tracing (the drum worked continuously on a spiral) was taken with the metronome still beating; the latter was then stopped, while the person kept on tapping the lever at the same rate for a period of one minute." The tables show the averaged reproductions for each five seconds. The total number of experiments is uncertainly stated; only one result "showing an average amount of variation" is published for each interval of each individual; tests were made upon seven persons.

Results: One hundred and fourteen out of 135 trials "point to the fundamental principle: That there is an interval of time, the value of which varies between .53 and .87, which

can be reproduced with considerable accuracy; but with all other intervals an error is made, which is plus for those above and minus for those below the so-called indifference point." The average Indifference Point was .71. The Constant Error was found gradually to increase as the Indifference Point was moved away from, in either direction. Twenty-one out of the 135 experiments were classed apart as irregular. "The irregularities consist in reproducing accurately long, in shortening long, and in lengthening short intervals." "The examination of such experiments, however, revealed the fact that the effect of fatigue is to make the error for short intervals *plus* instead of minus, and to increase the amount of variation made in the reproduction of long intervals; and that individuals under experiment are apt, when inattentive, to shorten long and prolong short intervals." "Diversion of attention and small experience are regarded as the cause of the great irregularities" shown in all the experiments.

As to the Law of Periodicity, "two remarkable points are revealed in the manner of variation of the curves. (1) The constant zig-zag of individual records; only in nineteen cases out of 140 were two sequent variations in the same direction. This would seem to indicate that an interval is judged more correctly after it is completed than before, and that correction is made for its error in the next reproduction, according to a standard which the mind carries, but to which the hand (or perhaps the will during the interval) cannot be accurately true. The origin of this peculiarity, therefore, appears to lie not in the judgment, but in the execution. (2) In all of the curves plotted, there were observed more or less distinctly, still larger and more primary waves. The prominence of these varied greatly; in some of the curves they were apparently absent, in others they were decidedly marked. These waves were no more prominent for one interval than for another—their length varies in the majority of cases between .6 and .9 min. and averages .73 min. This rhythmical variation seems not to be in the execution, but rather to have its origin in a rhythmical variation of the standard carried in the mind. That this is connected with the rhythmical changes in the nutritive condition of the cerebral centres, or produced by the vaso-motor rhythmical constriction of arterioles, it would be rash to deny or affirm or perhaps even to suppose."

Mr. Stevens refrains from any opinion as to the contradictions between his own and nearly all previous results, but suggest that these may be due to fundamental differences between single and successive reproductions.

Comment: As published, the number of experiments seems too few to establish conclusive results, as individual

differences and variations from general physical conditions are now known to be great. Also it is doubtful if the metronome used preserved alternate beats of equal lengths through the entire running down of its spring. On the whole, however, this paper is of marked value and reliability.

MICHAEL EJNER. *Experimentelle Studien über den Zeitsinn.* Inaugural Dissertation No. 137, Dorpat, April 18, 1889, under Prof. Kraepelin.

Purpose: To investigate (1) how we judge filled intervals of time. (2) What is the influence of fatigue and practice; (3) pathological disturbances. *Apparatus:* Stop-watch measuring .2 sec. *Method:* Average Error. *Experiments:* Both single and multiple reproductions were investigated; the norm was never heard but once; the assistant called "now" at the beginning and at the end of the norm; the subject announced his judgment by a signal; the length of the norm and reproductions were read from the watch by the assistant; reaction times of both subject and assistant were involved with other slight inaccuracies, but these compensated each other to a degree, and their sum was small in proportion to the unusually long intervals worked with. These were five in number, as follows: 30, 60, 120, 180, 240 seconds. The experiments were extended from Aug. 29th to December 13th, 1889, lasting one hour each day; the single reproduction was always at the same hour of the day. Ejner was the sole subject for his chief tables. For the class of multiple reproductions the judgment was always repeated twenty-five successive times; then the same norm was given again and another set of twenty-five reproductions made; for very long intervals a rest of about a half-hour was made between these two sets. Ten double sets of twenty-five reproductions each, were made by Ejner for each of the five intervals; these multiple reproductions were confined to no particular hour daily. To test individual differences, ten double sets like the above were tested upon two *commilitionen* for the interval 5, and six double sets for 240. For the pathological experiments three patients were selected from the clinique, all of them students. To investigate the effects of attention, 200 single trials each were made upon Ejner for the intervals 30 and 240, under each of the following conditions: (1) Same as his single reproductions above, except that he listened closely to an extra metronome (beating 200 strokes per minute) at the same time that he listened to the norm and made his judgments; (2) While performing mathematical problems.

Results: The tables are admirably arranged, particularly those which compare with each other the average progress of the double sets, for the purpose of showing the effects of fatigue and practice manifested between the two. The main results are as follows. (1) For single reproductions the Constant Error is always negative; for the multiple reproductions it is positive; in both cases it is a maximum at about 120. (2) The Average Error is less for single than for multiple reproductions, in the proportion of 2 : 3. (3) The increase of the Average Error follows Weber's Law approximately. (4) Practice decreases the Average Error. (5) Fatigue shortens the judgments; the effect of practice is to lengthen them. (6) The feeling of inner tension (*Anstrengung*) or attention is proportionally indicative of the accuracy of the judgment. (7) Pathological individuals show diminished sensibility and great irregularity of judgment, especially for long intervals, the Constant Error reaching wider extremes in both directions. (8) Distraction of attention by the metronome and arithmetical problems caused decrease of sensibility for long intervals and shortening of judgments, the latter especially for short intervals.

Comment: The objections repeatedly raised against results chiefly obtained upon a single experimenter, apply here again. The manner in which the results are combined and mathematically analyzed with reference to the influences of practice and fatigue offers great opportunity for merely fortuitous results, when based on such limited investigations; it may be doubted as of the similar calculations for the Law of Periodicity whether the same methods would again show like results with other experimenters. Otherwise the work is careful, thoughtful, and valuable.

HUGO MÜNSTERBERG. *Beiträge zur Experimentellen Psychologie.* Heft, 2, Freiburg, 1889.

This paper presents theoretical explanations, rather than experimental results. It aims to found all time phenomena on physiological processes; unless experimental results are correlated with their physiological causes, Münsterberg estimates such as "mere heaps of pedantic figures," and he is inclined to look upon all previous time experiments from this point of view. Münsterberg traces attention to feelings of muscular tension, and finds in our various rhythmic bodily processes, the indispensable measures and foundations of all time judgments. For short intervals, he thinks the rhythmic tensions of the sense organs themselves, are the basis of their

respective judgments, but the processes of respiration preponderatingly determine our time measurements, though unconsciously. A gradual rise and fall of tension-feeling accompanies each corresponding rise and fall of the equal inhalation and exhalation phases; according as impressions fall into like or unlike phases of respiration tension, or endure through like or unlike periods or multiples of such, so are they associated with, that is, measured by these familiar and judgment-determining processes.

The paper is one of the most thoughtful and suggestive yet contributed to the time problem, and a step in the right direction whether we give full acceptance to the particular theories announced or to his experimental results. His manner of presenting the latter is unfortunate; he tells us that "in cold blood" he suppresses the full figures until he "can prove what each period in the process means;" yet he gives his main results, if we understand him, as confirmation of his explanations regarding these same "periods."

Experiments: Wundt's time-sense apparatus as used by Glass, was arranged so that by an electric circuit, and a delicate key held in the hand, the subject could record his judgments while assuming any comfortable position, whether sitting or lying. Both the norm and reproduction were beat by the same electric hammer, enabling both the judgment of the norm and of the reproduction to be formed under the same conditions. The judgments were not, however, always fixedly recorded, but the position of the index each time the hammer fell was noted by two assistants, and averaged; with single reproductions, the assistant stopped the wheel when he heard the hammer fall; Münsterberg thinks the reaction-times involved do not exceed .05 to .08, and are too small to need correction. The experiments were of two classes — with and without a pause between norm and reproduction. The subject was never informed as to the character of the judgments he was making. The intervals tested ranged from 1 to 60 seconds. The method of average error was used. The only experiments for which definite results are given were 400 trials made upon Münsterberg himself with intervals from 6 to 60 seconds. The chief feature of these was, that two parallel series of tests were made; in the first, no regard was paid to phases of breathing; the second set was arranged so that the reproduction should begin in the like phase of breathing to that in which the norm had begun. This was accomplished, when the reproduction followed the norm without pause, by the assistant ending the norm (and thus beginning the judgment) upon the same phase of the subject's breathing as it had begun in; it will be noted that this always confined

the length of the norm to the length of the breathing or multiples thereof. Where a pause was made between norm and judgment, the assistant gave the signal for the judgment to begin, in the same phase as that in which the norm had begun, thus making the pause of variable length.

Results: No details are given. It is stated for experiments made without pause that when no regard was paid to breathing, the average error was 10% of the normal, and but 2.9% when the judgment and norm began in the like phase. For experiments with pause, the error was 13.3% when breathing was neglected, and 5.3% when like phases were maintained. When voluntary violent interruptions and variations were made by the subject during the tests, "judgment was entirely upset, 4 seconds appearing like 12, and 9 like 3." Münsterberg looks upon these results as evidence that there is no special function of *consciousness* to be called the time-sense, but that psycho-physically conditioned changes, which constitute the rise and fall of our bodily or muscular tensions, and chiefly those of breathing are the measures of our time presentations. "It is not the physically unconditioned transcendental apperception which functionates in time perception, but our time perceptions are the results of those physiological excitations which underlie our periodic changes." No constant error appeared in Münsterberg's work; the judgments were for all lengths about as frequently positive as negative.

Comment: If Münsterberg had asserted that one *may* measure off certain intervals of time by his breathings, no one would object; but that our functional rhythms unconsciously govern our time judgments, there is grave reason to doubt; if several such functions simultaneously formed our time measures, what confusion would result; yet what reason is there according to Münsterberg that one function should influence, and another not? Why the breathing and not the heart? The latter expending more energy, why should its rhythms not predominate over those of breathing? Why may not the peristaltic movements of the intestines disturb the influences of both heart and lungs, if such unconscious functions may influence judgments at all? Again, were breathing the chief measure, we should expect that the ordinary person could more accurately indicate the length of the usual breathing interval than any other, whereas this is not at all the case. I incline to believe that the interval most fixedly

impressed upon the conscious memory is the one that may be most exactly reproduced. The workman who has closely tended a particular trip-hammer for a course of years, would be more able to judge the time-beat of that hammer than the length of his breathing. Most of us are more definitely familiar with the tick of our clock than with our respiration rhythms which constantly vary; I could not tell if my ordinary breathing was faster or slower than usual; while having had unusual practice in second beats of a pendulum, I could instantly tell to a very small fraction, if a beat, newly heard, were longer or shorter than a second. I should judge correctly, it seems to me not by my breathing, but because the reproductive process of the higher centres constituting memory had acquired a fixed periodic habit of its own. Sufficient explanation of Münsterberg's experimental results may be found in the fact that his methods confined his tests to intervals of about one given length, or to the multiples of that length, namely, that of breathing. If the same number of experiments had been equally confined to any other interval, it may be suspected that a similar phenomenon, due to the practice or habit being thus limited while forming, would have been observed. Yet beside this, inasmuch as the published figures were only those tested upon Münsterberg himself, we must again re-iterate the great liability to the unconscious influence of prepossessing theories and conceptions.

F. SCHUMANN. *Ueber Contrast-Erscheinungen in Folge von Einstellung.* Preliminary communication to Philos. Seminary, University of Göttingen, Dec. 3, 1889. Nachrichten v. d. könig. Gesell. d. Wiss. No. 20.

In certain memory experiments similar to those of Ebbinghaus, letters were pasted at regular intervals upon a revolving drum and observed through a slit; Schumann noticed, that when the eye or the attention had for a considerable time become adjusted to, or familiar with a definite rate, a, of presentation of the letters, any immediate change to some other rate, b, caused the latter to be differently estimated than if the previous adjustment upon a had not occurred; if a were shorter or longer than b, the judgment of the latter in consequence appeared respectively shortened or lengthened. When the physical and mental condition was good the attention was better, and rapid intervals seemed shorter than

when reverse conditions obtained. Similar results were observed when metronome beats were presented under like conditions to the ear; when the attention had been adjusted to an interval of .7, one of .9 was judged longer than previously to such adjustment. Dr. Schumann thinks the sensory centres are the seat of these phenomena; that they adjust themselves to a given rhythm, and thus prepare themselves, as it were, to expect excitation at a given time. If the rate of excitation is changed, the expectation is unfulfilled, and the subject is surprised into a judgment longer or shorter by contrast. Experiments of a like nature were also made in measuring given distances; by drawing the finger along a scale by motion of the arm, similar results were obtained.

Comment: The explanation offered by Dr. Schumann for the phenomena discovered by him seems, at least, inadequate; to say that the sensory centre, after adjustment "expects" a certain rate of excitation is vague in the extreme; but as this point is to be spoken of presently in detail the subject will be deferred.[1]

GEORG DIETZE. *Untersuchungen über den Umfang des Bewusstseins bei regelmässig aufeinander folgenden Schalleindrucken.* Wundt's Philos. Studien, II, 362. cf. also, Wundt's Phys. Psych. 3te Auf., II, 248.

Another line of experiments begun by Georg Dietze in Wundt's laboratory with reference to the so called Compass of Consciousness, was brought by Dr. Schumann into correlation with his above theories in a later paper.[2] The experiments of Dietze were to determine the greatest number of metronome beats, that, given in a series, and then repeated, could be determined to be the same in the repeated series as in the original; it was found that the larger series tended to group themselves into rhythmic multiples; it was claimed that these rhythms could never be entirely suppressed; the largest number of beats was found to be 40, and these were obtained by five groups of eight beats each.

Wundt contended that these 40 beats were in consciousness

[1] Owing to the resemblance between the phenomena reported by the above author, and those forming the chief part of my own work, to be presented later in this paper, this is perhaps the place to state that Dr. Schumann's Preliminary Communication of Dec. 3, 1889, reached my notice Jan. 10, 1890, at which date my own experiments had been under way about three months, and the method already established according to which they were carried out to the end.

[2] F. Schumann. Ueber das Gedächtnis für Komplexe regelmässig aufeinander folgender, gleicher Schalleindrücke, Zeitschrift für Psychol. Band I, Heft I, S. 75.

simultaneously; that they expressed the limit compass of consciousness, and that the addition of another beat to the end of the series, drove out the first of the series; Wundt explained this phenomenon by his well-known theory of Apperception. Dr. Schumann contends against this view, and believes that the hearing centres are capable of adjusting themselves to the reproducing of certain series which they had received with sufficient frequency; that they can repeat these series with more or less accuracy according as the habit has been formed with more or less fixity, and also in proportion to the favorable or unfavorable length of the interval and of the series; thus the 40 beats of Dietze express the extent of the habit-capacity of the hearing or memory centres, rather than any simultaneous compass of Consciousness or Apperception.

G. STANLEY HALL and JOSEPH JASTROW: *Studies in Rhythm.* Mind. Vol. XI, No. 41, p. 55.

A work which approaches closely to many of the most fundamental processes of the time problem is the eight-page contribution of these experimenters. Two disks were fixed to the drum-shaft of a Ludwig kymograph; and cogs were fitted in their periphery in such a manner that, the disks revolving, and a quill pressing on the cogs, adjustable at various distances apart, intervals of different lengths and arrangment could be given as desired.

Three sets of investigations were made: to determine (A) for given intervals, what is the largest number of beats that can be accurately counted? The two intervals for which tables are given were .0895 and .0523. Of this set the authors say: "Counting objects and impressions is a very complex process, and slow, and hard to teach or learn. (1) The impressions in a series must of course be distinguished from each other. The ear, which does this most acutely of all the senses, unless it be touch, can discriminate $\frac{1}{132}$ (Helmholtz) or even $\frac{1}{500}$ (Exner) of a sec. under exceptionally favorable conditions. These of course are extreme limits, but from 24 to 40 beats per sec. can be distinguished by the average ear without fusing into a tone. The actual number of beats is also a function; that is in order that their discontinuity may be clearly perceived, four or even three clicks or beats must be further apart than two need be. When two are easily distinguished, three or four separated by the same interval approach nearer to the above limit and are often confidently pronounced to be two or three respectively. . . . (2) Counting requires a series of innervations, if not of actual muscular contractions. . . . The most rapid contraction

of antagonistic muscles in trilling by pianists who have given us their record, or the rapid lingual movements involved in aspirating the sounds *t*, *k*, recorded by a Marey tambour, we have never found to exceed and rarely to reach six double or twelve single contractions per sec., while few can make more than 4 or 5 double movements in that time. There is thus at any rate a wide interval between the most rapid innervations and the limit of discriminative audibility for successive sounds. Attention, in other words, discriminates sensation, more rapidly than the will can generate impulses How the fact is reconciled with any extreme form of the hypothesis of the identity of apperceptive and volitional processes is not easy to see. None would venture to assume that, because we can volitionally cut short the otherwise normal duration of a single innervation-impulse, by innervating an antagonistic muscle, the extreme limit of distinguishing elements in a series of noises marks really the limit of this abbreviation. (3) Counting involves the matching, pairing or approximative synchronization of the terms in two series of events in consciousness. However familiar both series may be, this is difficult. Many school children find it hard to keep step with others or to keep time with a drum or piano in marching; and savages have been reported to sight across each stick, used as a counter for animals they were selling, to keep the correct tale. . . . What now becomes of the lost clicks when we are constantly behind in counting, yet with great subjective assurance that we are right? It will hardly be sufficient to say that, when counting with great energy and concentration, we cease to attend to the auditory series, stretching the interval we caught the *tempo* of at the beginning of the series, as all short intervals are expanded when we come to perceive only our innervations. We may, however, conceive the earliest announcement of the impression of the first click in consciousness and the exit therefrom of the registry-innervation involved in counting it, as separated in time by some not inconsiderable proportion of the simple reaction time between ear and tongue. If the interval between the clicks is greater than or equal to this reduced reaction-interval, consciousness is done with the first click when the second arrives, and there is no error. If, however, the second click begins to be recognized in the focus of consciousness before this has completely initiated the act of tallying the first, and if the fastest rate of doing so has already been attained, then the third click will come a little earlier in the process, until at length a click in the later afferent stage will cease to be distinguishable from the perhaps more widely irradiated process of the earlier efferent stage of tallying, and will drop out

of consciousness and be lost, possibly after the analogy of the second of two sub-maximal stimuli in myological work, which produces no summation if extremely near the first in time. . . . We do not realize how far the fastest counting falls short of the fastest hearing. In judging of small divisions of time, we seem, as Vierordt thought, to take relatively large periods, perhaps as great as our psychic constant (or the time we reproduce with least change)—so large at least that we can overlook it readily, and then pair or otherwise group the subdivisions which do not get into the field of direct time-sensibility themselves. The focus of apperception is perhaps dominated by the rhythm of the largest and more slowly loading and discharging motor cells. Although we can discriminate a finer intermittency by means of the smaller sensory cells, this is prone to be done more in the direct field of consciousness, and these smaller movements of time speedily fall out of sense-memory into oblivion like knowledge or impressions not directly reacted on. If immediately known time be discrete, and temporal continuity be an inference, as seems likely, these finer temporal signs are somewhat analogous to the finer local signs discriminating motion and even its direction considerably within the ordinary limits of discriminative sensibility for stationary compass points."

The (B) set of experiments investigated, "Just-observable Differences of Duration." Subjects D. and S. made each 20 judgments when the middle interval was varied $\frac{1}{60}$ of the 4.27 secs. of the extremes, viz., ten times each way with no error. G. S. H. judged 90 times under the same conditions with no error, while J. J. made only 12 errors in 90 judgments. When the variation of the mean was $\frac{1}{120}$ of the same time of the extremes, D. and S. made no errors in 10 judgments, J. J. made 3 errors in 40 judgments, and G. S. H. made 2 errors in 30 judgments."

The (C) experiments concerned "Full and Vacant Intervals." "It is well known that if a horizontal line be bisected in the middle and one half untouched and the other half crossed by short regular perpendicular lines, the latter half will seem the longer. It was found that under certain conditions the same illusion held for the time-sense. . . . Full tables were constructed for four individuals. With 10 clicks the following vacant interval to be judged equal to it must be extended to the time of 14 to 18 clicks; 15 clicks seemed equal to the time of from 16 to 19. Preliminary experiments upon other individuals indicate that these differences are extreme. If the absolute length of interval is increased beyond from 1 to 3 secs., the illusion is less. It is also less if the

clicks are very near together. The illusion still holds, but is diminished if, instead of comparing clicks and a vacant time, more or less frequent series of clicks are compared. In these observations, also, the time between the two intervals became quite important. In general the illusion was less if this time was short; but if less than about $\frac{3}{4}$ of a sec. the illusion again became greater. Indeed, in a few cases an indifference time was found in which little or no illusion took place. This entire illusion, however, is reduced to a minimum, and with some persons vanishes, if the order of the terms be reversed, viz., if the vacant or less-filled interval precedes."

A. BINET. *La concurrence des êtats psychologiques.* Revue Philosophique, Fév., 1890.

This paper deserves mention as an interesting study of the effects of attention upon time judgments.

Many investigations have been made upon such questions as, The Least Perceivable Duration throughout the various senses; The Least Perceivable Difference of Change for the same; Complicated results from several like or disparate sensations received simultaneously or in series. But as these are not sufficiently pertinent to our main problem the reader is referred to a good review of them in Wundt's Phys. Psychol. 3te Auf., II, pp. 330–364.

Casting an eye back over the experimental field of Time Psychology, the results are found scarcely more satisfactory or conclusive than were those of the preceding chapter on the theories of time perception. Most experimenters have confined themselves to the determination of the Constant Error, Sensibility and Weber's Law, yet with difficulty, if indeed at all, can the results of any two of such determinations be harmonized, as the following table shows:

Investigator.	Year.	Constant Error.			Periodicity falls on Multiples of.	No. of Reproductions.	No. of Persons Tested.	Average No. of trials per interval per man tested.	Method used.	Weber's Law.	Sensibility.
		+	0	−							
Höring, . . .	1864	.306–.365	.365–.454	.454–1.428	. . . . .	8	1	10	R.&W.C.	. . . .	Inverse to length of interval.
Mach, ...	1865	. . . .	. . . .	. . . .	. . . . .	. . . .	6	. .	L. P. D.	Does not hold.	Max. at .375 sec. thence both ways.
Vierordt, . .	1868	.25 (3.–3.5)	3. –3.5 2.2–2.5 Eye 1.4 (for H) 1.5 (for N)	(3.–3.5)–8.	. . . . .	{ 8 / 1 }	3	. .	Chiefly R.&W.C.	" " "	" 1.–1.5 " "
Kollert, . . .	1882	.4–.755	.755	.755–1.836	. . . . .	1	7	3	L. P. D.	" " "	" .755 " "
Estel, ...	1884	. . . .	. . . .	1.5–8.	(all) .75	1	10	2	L. P. D.	" " "	Follows inversely Periodicity .75 (all)
Mehner, . . .	1884	5.–12.1	{ .71 and 5. }	.71–5.	(odd ones) .71	1	1	10	L. P. D.	Does not hold below .71; Holds Appx. above 7.1.	" " " .71 (odd) (Up to 7.1 above this is constant)
Glass, 1st set,	1887	.7	.7	.7–15.	(all) 1.25	1	1	100	A. E.	Held Appx. throughout.	" " " 1.25 (all)
" 2nd set,		.7–1.8	1.8–5.4	5.4–15.	do.	1	1	100	do.	. . . .	" " " " "
" 3rd set,		.75–2.	2. –4.	4.–9.	do.	1	1	100	do.	. . . .	" " " " "
Stevens, . . .		.71–2.85	.71	.26–.71	. . . . .	Through 1 min.	7	20	do.	do.	. . . . .
Ejner,	1889	30.–240.	Least at 120.	. . . .	. . . . .	25	Nearly all on 1	100	do.	. . . .	Greatest at 120. Decreases thence both ways.
"		. . . .	do.	30.–240.	. . . . .	1	6	100	do.	. . . .	. . . . .
Münsterberg,	1889	No Constant Error was found.			. . . . .	1	3	. .	do.	. . . .	Greatest in Equal Phases of Breath'g.

As a summary of these experiments the most conclusive results may be said to be as follows:

Nearly all persons, under nearly all conditions, find a particular length of interval more easily and accurately to be judged than any other.

This Indifference Point or interval of best judgment is very variable for different individuals and for different times and conditions.

The sign of the Constant Error is usually constant in both directions from the Indifference Point.

Where norm and reproduction are single the Constant Error is minus for intervals longer, and plus for intervals shorter than the Indifference Interval.

Where norm and reproductions are multiple, the Constant Error is plus for intervals longer, and minus for those shorter than the Indifference Interval.

The majority of evidence is strongly against the validity of Weber's Law; also against any fixed or constant Periodicity.

Later investigators look to physiological processes for explanation of time-judgments, and particularly to rhythmic habits of nerve centres. Whether such processes as breathing, pulse, leg-swing, etc., govern our perceptions, or whether the more general rhythmic functions of the higher cephalic centres are in themselves the basis of time-judgment is now the important question. The discussion of this question, together with the author's experimental results, will occupy the following sections of this study.

THE PROCESS OF RECOVERY FROM THE FATIGUE OCCASIONED BY THE ELECTRICAL STIMULATION OF CELLS OF THE SPINAL GANGLIA.

By C. F. Hodge, Ph. D.

Experiments Upon Cats.

The two preceding chapters, of which the following is a continuation, appeared in this Journal in May, 1888, and May, 1889. In the first it was shown that stimulation of a nerve going to a spinal ganglion produced a marked change in the appearance of the ganglion cells, as seen under the microscope. This change was most pronounced in the nuclei, which might, upon stimulation of seven hours, lose forty per cent. of their bulk. The cells themselves, further, decreased little in size, but in many cases the cell protoplasm became extremely vacuolated, and as a third difference the nuclei of the cell capsule shrunk to a noticeable degree.

In the second paper the attempt was made by a series of experiments, in each case the nerve being stimulated in the same way but for a different length of time, to ascertain whether the amount of change in the cells was directly proportioned to the length of time the work was continued. In a general way this was found to be true. In all cases the nerve upon the right side of the animal was stimulated, while that upon the left was at rest. After the experiment the stimulated ganglion was examined, using its resting mate of the left side as a normal to compare with.

By this method it was found that the nuclei lost respectively upon stimulation of 1 hour, 2½ hours, 5 hours and 10 hours, 22%, 21%, 24.3% and 43.9% of their bulk.

The series of experiments which I propose now to describe had for its object a study of the recovery of spinal ganglion cells after fatigue. If the changes seen in the specimens, the shrunken nucleus, vacuolation of protoplasm, shrinkage of

the capsular nuclei, are, in truth, evidences of normal or physiological fatigue, a period of rest being allowed, recovery should take place. Accordingly, a series of cats were worked in exactly the same manner for the same length of time and allowed to rest, before excision of the ganglia, different lengths of time, in order to observe the process of recovery, if it took place, at different stages.

Method.

I find that in previous descriptions I did not devote enough space to the method employed. And as this has been still further perfected by experience and by the use of the best available apparatus, I wish, before considering the experiments, to describe the method in some detail.

In the first place, in order to compare one experiment with another, we must know that the stimulation used in both is the same. We must, therefore, have in the primary circuit, first, a galvanometer to give us the strength of current; second, a resistance box or rheocord of some sort to control any irregularities in the strength of the battery; third, an arrangement of some kind to make and break the primary circuit at regular intervals, since continuous stimulation is not employed; fourth, a signal to record the beats of the interrupter; and fifth, an ordinary induction coil. For the battery I have used in the last series of experiments three grove cells. A Weston's direct reading am-meter, reading from 0 to 15 ampères, was placed next the battery. From this it was possible to read off the strength of current at any time. Next this in the circuit was placed an ordinary resistance box with rheocord attached. This is quite necessary for exact work, as the battery was set fresh at the beginning of each experiment and increased in power for the first hour or so and then gradually weakened until the end of the five hours, during which the stimulation lasted. These variations could generally be compensated for by merely sliding the bridge of the rheocord. The interval of rest and stimulation was the same as that adopted for the last series of experiments, viz., 45 seconds rest alternating with 15 seconds stimulation. In my first experiments a key was placed in the circuit and the circuit was made and broken by hand.

I am glad to acknowledge to Dr. Lombard my indebtedness for a most serviceable little device which removes this irksome feature of the experiment. A small nickel clock forms the basis of the contrivance. It must be provided with a second hand. The glass face-cover and all the hands are removed, and upon the shaft of the second hand is fastened an eccentric zinc disc $2\frac{1}{2} \times 3$ cm. in diameter. In front of the clock is held by a post, properly placed, a lever of hard rubber 15 cm. in length; the longer arm of the lever, 8 cm., is between the post and the clock, so that this end, which is tipped with a small gutta-percha wheel, to reduce friction, will tilt back lightly upon the eccentric. The other arm of the lever carries two light copper wires tipped with platinum. The platinum tips, extending downward at right angles from the lever, dip into a glass mercury cup. Thus the motion of the eccentric upon the second shaft is made to tilt the lever in and out of the mercury cup every minute. By placing the cup upon the head of a screw, so that it can be raised or lowered at will, and by proper shaping of the eccentric disc, it is very easy to arrange it so that the circuit is made through the mercury in the cup 15 seconds and broken 45 seconds, which is the spacing of intervals desired. The whole is arranged upon a small board, into which are screwed two binding screws for convenience in joining up with the circuits. It is only necessary to connect this automatic make and break key with the circuit.

It was decided to use 20 stimuli per second, and this rate was obtained by loading the interrupting hammer attached to the induction coil. As this was apt to jar out of adjustment, I was compelled to take the record of the interruption by placing a signal in the circuit which should write its vibrations upon a smoked drum, under the tracing of a signal in circuit with a seconds clock.

By these means it was possible to control the stimulation apparatus very accurately. A half ampère, as read from the galvanometer, was used throughout the series. The automatic key gave regular intervals of 15 seconds stimulation, with 45 seconds rest. The beat of the interrupter was kept

at 20 per second. The secondary coil was of course kept at the same place in each experiment.

The animals used were kittens six to eight weeks old, and a word as to their preparation may not be out of place. Nothing was fed after the commencement of the experiment, but up to that time they were so well fed that it was thought a fast of even twenty-nine or thirty hours would not complicate matters seriously, if at all. In operating, the kitten is laid on a holder and gently brought under the influence of ether. When fully anæsthetized the skull is trephined at about the parietal eminence, and a slit is made through the *dura mater*. The trephine should be the smallest size, 5 to 7.5 mm. in diameter. With kittens it is possible to lift out a small piece of the bone at this place with the point of a knife blade, with generally less loss of blood than is occasioned by trephining. Now, holding the head with the left hand, with the thumb upon the vertex, the tip of the first finger upon the angle of the right jaw, the tip of the third upon that of the left jaw, introduce, with the right hand, through the opening in the skull, the blunt end of a 3 mm. glass rod, and aim it directly at the angle of the right lower jaw, the opening being invariably made in the left parietal bone. The probe will then strike the floor of the skull, having pierced the right optic *thalamus*, and the right *crus*. Work the probe across the floor of the skull about three mm., to either side of its first position, toward the right and also toward the middle line and withdraw it. Introducing the probe again, direct it forward as before, but down, aiming to pierce the left optic *thalamus* and the left *crus*. Take about one 3 mm. step with the end of the probe to right and left, withdraw the probe and close the skin over the wound. The aim of the operation is, of course, to destroy the sensory and motor tracts in the *crura*. Remove the ether and allow the animal to recover. If the operation has been successful the animal will evince no signs of pain or distress, but will remain as though quietly sleeping during the rest of the experiment. In some cases, however, the animal does show signs of restlessness for a few minutes after it recovers from the ether. These gener-

ally pass off very soon and give place to the condition of quiet desired.

The next step is to get the electrodes over the desired nerves, in this case the nerves of the right brachial plexus. Turning the animal upon its back, expose the external pectoral muscles by an incision in the skin about two inches long midway between the *sturnum* and *axilla*. Cutting through the external and internal pectoral muscles will now expose the subclavian artery and vein, and just underneath these can be plainly seen the nerves of the brachial plexus. In order to prevent hemorrage, I always take the muscles up with a double row of ligatures and make the cut between them. Free the plexus of fat for a short distance and separate it from the subclavian vessels, and, not including these, slip over it from behind a two tined platinum electrode.[1] Thus the current is made to pass through the nerves obliquely.

The stimulation may now begin. The nerves are not divided, and every muscle of the right fore limb should contract. This, in fact, is an important test of the proper working of the apparatus. If all the motor nerves are stimulated, and are conducting the impulses properly to the muscles, there is every reason to think that the sensory nerves are also conducting their impulses centrally to the cells of the spinal ganglia.

The animal is now carefully tended while the stimulation proceeds. The temperature is frequently taken, and heat applied or removed as the case demands. Respiration and pulse are watched. Lymph is apt to collect in the *axilla* about the electrodes, and should be frequently wiped up with absorbent cotton. The skin is drawn together over the wound and held with a clamp, and the wound is further protected with an ample pad of cotton.

In this series of experiments, the stimulation was continued for five hours in each case. At the end of this time the animal

[1] The electrode first used was an ordinary platinum electrode such as was used to stimulate a muscle-nerve preparation. Thinking that it would be better to have the platinum tips guarded, I made an electrode by letting heavy copper wires into deep grooves in a strip of gutta-percha. Platinum wires were soldered to these, and lie half-exposed in shallow grooves upon the inner side of each of two fork-like prolongations of the gutta-percha.

is gently removed from the board, wrapped up and laid in a warm place, where it is left to sleep the desired length of time. When this has expired, the work of removing the ganglia is begun. This is done as quickly as possible. A single cut with a scalpel severs the medulla at the *foramen magnum*. The skin is opened along the dorsal median line, some of the muscles cut away, and, with a pair of slender pointed bone forceps, the arches of the *vertebræ*, from the fifth cervical to the second thoracic, are removed, care being taken not to injure the cord or spinal nerves. A preparation is thus obtained which should resemble, so far as the brachial region is concerned, the plate upon page 374 in Wilder and Gage's *Anatomical Technology*. I have always taken the additional precaution before removing the electrodes of tying a ligature around the nerves included by the tines of the electrode, so that I may be sure to note the fact, if any important branch of the plexus has escaped stimulation.

In this series I have used for study only the ganglia of the first thoracic and eighth cervical pairs, and of these the first thoracic pair is dropped into about 5 cc. of 1% solution of osmic acid, the eighth cervical into saturated mercuric chloride solution at 40° c. The ganglia should be in their respective killing solutions within five minutes from the time the animal is killed. My own practice has been to leave them in both of these fluids for four hours, after which they are carried through the remaining processes in the usual manner. Minor points of technique are, however, not essential, so long as this one point is observed, viz.: *that the two ganglia to be compared are carried through all processes of preparation absolutely together, from the body of the animal to the microscope slide.* We then have under the microscope, side by side, sections of both ganglia of the same pair, one of which has been experimented with, while the other remains as a normal with which to compare it.

The method of investigation from this point on is the same as that employed in the former series of experiments. The nuclei and cells are measured microscopically, the longest and shortest diameter of each being taken. The mean of all the measurements for the worked or normal nuclei is taken as

the diameter of a sphere. As the nuclei are very nearly spherical, this sphere may be conceived to represent the average bulk of the nuclei in the set, from which the average diameter is obtained. And a comparison of the average sphere of one set with that of the mate to the set gives in a crude, but in the most exact way yet attained, an idea of the quantity of change produced by the conditions of the experiment.

As there is often reason to distrust averages, I will give the actual measurements as they occur in my notes for Cat 17. The measurements were made with a Zeiss eyepiece micrometer ruled to $\frac{1}{4}$ micron. divisions (eyepiece, 8; objective 4.0 mm. × 500), hence each division equals $2\frac{2}{5}$ μ. They are given as they were read, in units of the micrometer eyepiece.

CAT 17.

Measurement of the diameter of the Nuclei.

After 5 hrs. Stimulation and 0 hrs. Rest.		Normal.	
Diameter.	Number of Measurements.	Diameter.	Number of Measurements.
8.5	3	9.	3
8.	1	8.5	6
7.5	4	8.	28
7.	17	7.5	17
6.5	17	7.	61
6.	48	6.5	29
5.5	30	6.	33
5.	44	5.5	12
4.5	14	5.	11
4.	17		200
3.5	4		
3.	1		
	200		
200 cells measured, average diameter for the set, 5.39.		200 cells measured, average diameter for the set, 6.83.	

The above is sufficient to show that the mean in these diameters is a fair average. The measurements stand in about equal numbers above and below it in both cases. The diameters of the normal nuclei are throughout larger. The largest nuclei being found among the normal cells, and the smallest among the stimulated cells.

The results of this whole series of experiments may be seen at a glance from the following table:

Series to show the Influence of Rest.

Right brachial plexus of each stimulated in the same manner for five hours.

		Nuclei.		Cells.
	Rest.	Mean diameter of Nucleus in μ.	Shrinkage in per cent.	Mean diam. in μ.
Cat 17.	0 hrs.	16.40 Left, normal. 12.93 Right, stimulated.	48.8	57 52
Cat 16.	6.5 hrs.	16.70 Left, normal. 15.09 Right, stimulated.	26.	56 54
Cat 21.	12 hrs.	16.34 Left, normal. 14.73 Right, stimulated.	26.	55 51
Cat 19.	18 hrs.	17.08 Left, normal. 16.03 Right, stimulated.	18.	56 55
Cat 18.	24 hrs.	17.01 Left, normal. 17.11 Right, stimulated.	+ 2.	58 58
From another series.[1]				
Cat 7.	Normal.	14.20 Left. 14.54 Right.	+ 6.9	

[1] Am. Jour. Psy. May, 1889, p. 395.

In this series the stimulation was severe. It must be remembered that during the period of work, so-called, the stimulation is applied for only 15 seconds each minute. Five hours, therefore, of stimulation represents only one hour and a quarter actual working of the cells. But in this short time the change is marked, as is shown by a shrinkage of 48.8 per cent. in the nuclei of the side stimulated. The cells, as before, shrink little, and the cell protoplasm exhibits considerable vacuolation.

The quantities expressed in the above table, while they show that the nerve cells do gradually recover from the effects of fatigue, tell nothing concerning the process of recovery. The table is, in fact, but a poor expression of even the amount of change. In the first place it is impossible to measure accurately the irregular and jagged outline of the worked nucleus. Our practice has been to measure to the

tips of the jagged points into which the nucleus is prolonged; and this would evidently tend to make the computed bulk larger than the actual volume. In the second place, the quantities in the table are averages, whereas for our purpose extremes are most interesting. In a study of the cells of a worked ganglion, we see some nuclei which are not affected at all; and this we should expect because it is impossible to stimulate all the nerve fibres going to a ganglion without disturbing its blood supply. We next find nuclei which are slightly worked. In their even outline there may be here and there only a slight indentation, with here and there a vacuole in the cell protoplasm. These nuclei may have shrunken 5 or 10 per cent. And so we pass, by all degrees of difference, to the cells which show extreme changes. And here the cell protoplasm is riddled with vacuoles and the nucleus has skrunken to a densely staining speck, which must have lost 75 to 80 per cent. of its original volume.[1]

To trace the process of recovery in a nerve cell from its condition in fatigue to that in the resting state, the ideal thing would be to watch a living nerve cell continuously for the required length of time. For the present, however, we have only the prepared specimens taken so as to give us presumably five steps in the process. The chief interest for us at present attaches to the nucleus.

To begin with, we find the normal nucleus a round or oval body with an average diameter, in the cat, of about 16μ. The outline is even and sharply defined. In the nucleus, generally near the center, is a single (for the spinal ganglion cells of the cat) round nucleolus. Beside the nucleolus, the normal nucleus, as seen in a section, has generally from one to four or five rather coarse granules or agregations of smaller granules, and is spun through with a fine reticulum. On the whole it appears clearer than the protoplasm of the cell; as though the greater part of its contents were unstained. This appearance it was that gave rise at first to the idea that the nucleus was a large vescicle or vacuole in the midst of the densely granular protoplasm.

[1] See plate Am. Jour. Psychology for May, 1889, p. 402.

As the cell is worked, the nucleus gradually loses its sharp outline and at the same time becomes clouded and filled with darkly staining granules. Two opinions are possible here: either that the granules already present in the nucleus and its reticulum, being drawn closer together in shrinking, give it a darker appearance, or that new granules are formed in the nucleus. My own observations incline me toward the latter view. The stimulation is continued, and the nucleus shrinks smaller and smaller, and becomes so dark in osmic acid specimens as to be hardly distinguishable from the almost black nucleolus. Whether the extreme limit of fatigue has been reached in any of the cells examined, is of course impossible to say; but if recovery can be taken as a sign of normal action, then the fatigue occasioned by working for five hours, as above described, is not abnormal or pathological.

The process of recovery is in general the reverse of that of fatigue. The nucleus and cell gradually return to the normal appearance. At the end of six and a half hours the cell protoplasm has apparently almost or quite recovered. Vocuolation is not observable in the specimen which has rested this length of time, or in any specimens which have rested for a longer period. The nuclei, however, although they have gained much in size, retain, to a marked degree, their dense stain. The process of recovery in this respect is not entirely completed in all the nuclei which have rested for 24 hours; it is still possible to find a few large but densely stained nuclei.

A study of the ganglion cells after long periods of complete rest has brought out a point of interest to the general histology of the nervous system as well as to the special subject in hand. An appearance, often noted in nerve histology, has hitherto complicated all our experiments. This is the fact that individual cells in the same ganglion present such great histological differences. Ranvier[1] calls attention to this fact

[1] Ranvier, Traité d' Histologie, Paris, 1889, p. 802. "How is it that a little spinal ganglion, placed in a solution of ammonium bichromate, all the elements of which are therefore submitted to the same influences, contains side by side cells modified in a manner so widely different? This is a fact which we cannot yet explain; but, upon which we must insist, because we see it repeated in the spinal cord, the cerebrum, the cerebellum, etc.; that is to say, in all organs containing ganglion cells."

and shows that it cannot be due to the action of the reagents, but must be attributed to some differences between the cells themselves. So in my own experiments, even in sections of normal ganglia, I invariably find a few cells which have all the appearances of being worked. The number of these in the normal ganglia varies, but may reach 5 to 10 per cent., while in the stimulated ganglia they often exceed 90 per cent. My supposition in such cases was that some of the ganglion cells had been more or less fatigued by the normal activity of the animal. But this was merely supposition. It might also have been supposed that these cells were in process of degeneration. After we have wrapped an animal up in cotton batting, however, and laid it in a warm chamber at constant temperature for twenty-four hours, its brain having previously been destroyed so that it makes no voluntary movements, after scarcely a sensory impulse has disturbed the cells for that length of time, we find, as we might naturally expect, all the cells in the most perfect resting state. The cells appear uniformly full, and not a single shrunken nucleus can be found. The nuclei, in fact, appear larger, rounder, and clearer than in any specimen I have hitherto examined. It would seem quite possible, then, that the differences between ganglion cells, seen in sections from the same specimen, may be due to the phase of nutrition or of functional activity in which each of the cells happened to be when it died or was killed by the reagent.

We have, in the foregoing, materials from which to construct a curve that may provisionally, at least, be taken to represent the process of fatigue and recovery in the cells of the spinal ganglia. Whether these results are applicable to the fatigue of nerve cells in general does not concern us at present. And whether the action of the nucleus may be fairly considered as an index of the whole process is open to question. But we have shown that this shrinkage of the nucleus is directly proportional to the duration and also to the strength of stimulation, and in general inversely proportional to the length of the period of rest. It is the only index we have at present, and we may be permitted to use it with the understanding that the curve obtained is entirely provisional.

The curve of fatigue for a muscle is generally described as a straight line, which falls more or less rapidly according to its load and the strength and frequency of the stimuli applied to it. That of a nerve fibre has been shown, for short intervals at least, to be a straight line which remains parallel to its base line; *i. e.*, within physiological limits a nerve fibre is not susceptible of fatigue.[1]

No curve representing the fatigue of the nerve cell, drawn directly from observation of the cell itself has hitherto been obtained. The nearest approach to this is perhaps to be found in such work as Mosso has done for the fatigue which manifests itself in voluntary muscular contractions.[2] If the curve which Mosso obtains can be taken to express the fatigue of the brain cells; we may say that the nerve cell tires rapidly at first, then very slowly, or possibly holds its own for some time, and finally falls quite rapidly again to a condition of complete exhaustion. If now we plot the percentages given in the table for a fatigue series (this JOURNAL, II, May, 1889, p. 395), we find a curve quite similar to some of the curves obtained by Mosso.

We have from the table above referred to, slight stimulation, for 1 hour, 2½ hours, 5 hours, and 10 hours, causing a shrinkage in the volume of the cell nucleus of respectively 22 per cent.; 21 per cent.; 24.3 per cent., and 43.9 per cent. This is represented to the eye by the dotted line in Fig. 1.

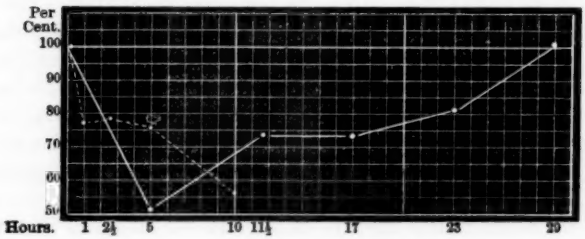

FIG. 1.

[1] H. P. Bowditch. On the Nature of Nerve-force. Jour. of Physiol., Vol. VI, p. 133.

[2] A. Mosso, Les lois de la fatigue, étudiées dans les muscles de l'homme. Travaux de Lab. de Physiol., de l'université de Turin, 1889. See plates, pp. 178, 185, 186.

By the continuous line of the figure is represented the process in the series of rest experiments, in which five hours of severe work has caused a shrinkage in the nucleus of 48.8 per cent.; recovery taking place as indicated by the second part of the curve. The curve of recovery in this instance is seen to rise quite rapidly at first, then more slowly, and again more rapidly to the normal.

I have already said that these curves are only provisional. In fact, they are introduced with the purpose of showing that in some degree they cannot be relied upon, rather than of attaching any permanent value to them. A most important factor in the shaping of these curves has hitherto been entirely ignored.

We have been endeavoring from the first to demonstrate the changes which occur in the normal functional activity of the nerve cell. That the changes already described do relate to the normal and not to the pathological action of the cells is proved by the facts that no pathological condition, which can affect the cells of the spinal ganglia, has been introduced into the experiments; that the changes in the cells are proportional to the severity and duration of their stimulation; and that the changes accompanying recovery are so far as we can see the natural reverse of those occasioned by fatigue. If, then, these changes are normal, why should there not be a rhythmic curve of rest and activity demonstrable in the normal activity of the animal. No more fundamental rhythm exists, in either physiology or psychology, than that of activity and rest, sleep and waking. And this rhythm, if not entirely dependent up on the condition of the nervous system, is, to say the least, very intimately connected with it. And if, as we know, marked changes are demonstrable in the normal activity of the cells of glands during hunger and digestion, (again rest and activity) why should not changes capable of demonstration occur in the rhythm of normal activity and rest in the cells of the nervous system?

If such a rhythm exists in the cells of the spinal ganglia, it is evident that such curves as we have obtained may be profoundly influenced by it. A stimulation of five or ten hours is physiologically a trivial matter compared with a fundamental rhythm which has become through generations an established fact in the economy of an animal species, and if the

changes in such a rhythm are similar to those which we have demonstrated by means of artificial stimulation, then clearly our results in each case have been *resultants* between the influence of our stimulation and the tendency of the rhythm at the time. Such considerations necessitate a study of the normal rhythm of sleep and activity in the animal employed. To this end I have kept under constant observation for a week a half-grown kitten similar to the ones used in my experiments. The sleep of such a kitten depends largely upon the amount of food given to it. When fed to repletion, it would sleep as much as eighteen hours a day; and even when sparingly fed, slept twelve and one-half or thirteen hours. It seemed to be able to sleep equally well day or night. In fact it will probably be necessary to study the next phase of our subject in some animal which has a more pronounced daily rhythm than that found in the cat.[1]

In no animal is this daily rhythm more constant or better developed than in our day birds. I have already made sections of the spinal ganglia of pigeons and English sparrows, taken at morning and night, and so far have found that the ganglion cells of these birds killed at night do show changes exactly similar to those produced in the cells of cats and frogs by artificial stimulation. The differences, further, between the morning and night cells are much more marked in English sparrows upon a cold and snowy day, for example, than I have been able to produce by the most severe electrical stimulation. The results of these experiments are, however, reserved for the present.

To conclude, then, we have as the result of the above series of experiments the following facts:

First, that spinal ganglion cells of kittens do recover from the effects of electrically stimulating the nerve going to them.

Second, that this recovery is a slow process. It is not complete after a rest of 18 hours; but is found to be about complete after a rest of 24 hours.[2]

[1] It will be noted that if the cat has no marked daily rhythm of rest and activity, then our curves are more probably correct.

[2] I have purposely omitted any attempt to discuss in this place the literature bearing upon the subject. This I hope to do in some more appropriate place; a general discussion of the literature touching the similar stimulation of gland and muscle cells, it has seemed, would necessitate the introduction of minute details of remote interest to psychology.

PSYCHOLOGICAL LITERATURE.

I.—NERVOUS SYSTEM.

Histogenese und Zusammenhang der Nervenelemente. W. His. Archiv für Anatomie und Physiologie. Anat. Abthl. Supplement-Band, 1890.

This paper contains the substance of an address made on August 7, 1890, before the Anatomical Section of the International Medical Congress at Berlin. His begins with the question of histogenesis. At the time of separation, the medullary plate consists of a single layer of epithelial cells forming when cut across a nucleated middle zone, and two non-nucleated zones, one above and one below the former. The part of the cell body above the nucleus soon forms a striated pillar or stem with an expanded base, and the bases fuse to form a limiting membrane. The part below is also striated, but soon breaks up into short branches on a more or less divided stem which form among themselves a meshwork. By the formation of the medullary tube, the part above comes to be the wall of the enclosed canal, while the part below becomes the more excentric portion of the surrounding substance. The former, which thus represents the wall of the ventricular cavities and the central canal is designated as the columnar layer (*Säulenschicht*), the latter, as the limiting mantle (*Randschleier*). It is the limiting mantle which grows extensively both by enlargement of existing elements and formation of new cells. The entire tissue thus formed is designated as the myelo- or neuro-spongium, and the individual cells as spongioblasts. In the adult it is the innermost layer of spongioblasts which form the ventricular epithelium. His has always held the view that the branches formed a net-work in the limiting mantle. The investigations of Ramon y Cajal lead to the view that the branches of the cells are not morphologically continuous, though they may be closely apposed.

Almost from the first there are to be found among these epithelial elements another group of cells, the germinal cells (*Keimzellen*). These cells lie mainly in the columnar layer of the neurospongium, are variable in number according to the age of the embryo and the location in the nervous axis, undergo rapid division, and are amœboid in their early stages. In human embryos the last germinal cells are visible at the end of the second month. The protoplasm becomes accumulated at one side of the nucleus in a conical striated mass, and in this form they are designated neuroblasts, the conical prolongation being the beginning of the axis-cylinder prolongation. The tendency to wander leads to the early formation of a layer of neuroblasts in the limiting mantle, where they constitute the so-called mantle layer (*Mantelschicht*). While the cells themselves remain for the most part within the limiting mantle, sending their axis-cylinder prolongations beyond it in various directions, it sometimes happens that the cell body passes more or less beyond the limits of the neurospongium. For the most part these exceptional cells are overtaken in turn by the limiting mantle and finally buried in it, but there seem to be cases where this does not occur. This wandering tendency is strongly developed in parts of the *medulla oblongata*, and the olivary bodies are formed from cells which have travelled a long course. The medullary plate is thus composed at the start of epithe-

lial and germinal cells. At the time of first multiplication of the neuroblasts, blood vessels enter the medullary plate from without, but no other elements appear. About the end of the second month in the human embryo, there appear amœboid connective tissue cells with dark nuclei. They are first seen on the outside of the neurospongium, but gradually become scattered through it. These form one constituent of the neuroglia. The neuroglia then of the adult is of mixed origin, being the neurospongium plus the connective tissue cells just mentioned. Deiter's cells he therefore considers as genuine connective tissue cells.

The neuroblasts of the medullary plate develop nerve fibres which either pass out as centrifugal fibres or remain as intra-medullary. The sensory roots come from the spinal ganglia. Here the cells are at first bipolar, but gradually change to the form where they give rise to a T-process. Passing by the description of the origin of the cells of the spinal ganglia, we come to the discussion of the origin of the sympathetic ganglia. The arrangement here is remarkable. That the sympathetic ganglia are not simply constricted off from the spinal ganglia is indicated by the following facts: The spinal ganglion cells are fully formed before the sympathetic ganglia appear, and the cells of the latter are unlike those of the former. The *rami communicantes* are formed before the sympathetic ganglia. It appears that the *rami* lead the way, and that undeveloped germinal cells, which appear in the spinal ganglia, then follow to the point of the future sympathetic ganglion. From the chain of the lateral ganglia the other orders of ganglia are developed in a similar manner.

The sensory nerves belonging to the organs of special sense appear to develop after the manner of the spinal sensory nerves, save in the case of the optic. Here he recognizes that the optic nerve may contain fibres that develop and conduct in reverse directions, as demonstrated by Ramon y Cajal. In all sense-organs the distinction between the spongioblasts and the functional germinal cells reappears.

Passing to the second part of the paper, the connection between the nervous elements, the conclusions may be more briefly stated. Within the central nervous system each cell gives out only one axis-cylinder process. The cells of the spinal ganglion give out two. The arrangement in the sympathetic nerve-cells must be left open until the fate of the spiral process can be determined. The axis-cylinder prolongation is first to appear in the nerve-cells and for a long time is the only prolongation they have. As at a very early period embryos have a nervous system without nerves, so there is a period when the nervous system consists only of cells and single long fibres running from them and when the felt-work of fibres due to protoplasmic prolongations and branches of the axis-cylinders is wanting; yet this kind of a nervous system is capable of complicated physiological activity, as can be seen in young larvæ of frogs and fish. Only at a later period are the protoplasmic prolongations developed. In man this occurs in the embryo about the end of the second month. In the cerebral hemispheres their development is subsequent to that in the spinal cord. As there is no evidence for continuity between any of the prolongations of any two nerves or nerves and cells, but in the central system all prolongations are closely matted together in a diffuse intermediate substance, it must be this latter which in some way establishes the final connection between the various elements. On the growth of the axis-cylinder His makes the point that a long time may elapse before it reaches its destination, but having reached it, it ceases to grow. The power to grow is not lost, since on cutting the end from the fibre it grows again. Why it normally stops growing then, has yet to be explained. Concerning the cells of Golgi's second type, the central cells, they appear to be of later origin in the nervous system than the others, and it is suggested

that perhaps the resistance to development with which they meet in the more completely formed tissues may account for the diffuse character of their axis-cylinder prolongations. One interesting deduction from the laws of growth can be applied to the completed nervous system. Since the nerve-cells and fibres start from fixed points, those that appear first in development will be more or less overgrown and covered by those which appear later. This is illustrated by the relations of the nuclei of the *hypoglossus*, lateral column, the ascending root of the *glosso-pharyngeus* and *vagus*, etc., in a cross-section of the *medulla*. No one can read this paper of His without assenting to his final statement that embryology stands foremost among the means which we have at our command for unraveling the organization of the central nervous system.

Zur feineren Anatomie des centralen Nerven-systems. Erster Beitrag. Das Kleinhirn. A. KÖLLIKER. Zeitschrift f. Wissen. Zool., B. 49, H. 1. Mai, 1890. Taf. XXX—XXXIII.

Under this title Kölliker has reviewed the results obtained by Golgi, Ramon y Cajal, and himself, laying of course the principal emphasis on the method of silver impregnation introduced by Golgi. The lower mammals, cat, dog, etc., are largely used in these studies, and it is not always clear how far the several points have been made out for man, but I will endeavor to give a description of the elements in the human cerebellar cortex as they are now regarded by Kölliker.

The *Molecular Layer:* The cells of Purkinje are somewhat flattened and their enormously developed protoplasmic prolongations lie in a plane at right angles to the long axis of the cerebellar folia. These prolongations end free. The axis-cylinder prolongation gives off lateral branches, some of which at least turn back towards the molecular layer, while the main stem passes on to become a medullated fibre. The small cells of the Molecular Layer: (*a*) The peripheral small cells lie in the outer half of the molecular layer and have well-developed protoplasmic prolongations. The axis-cylinder prolongation is present, but its character and distribution have not been determined. (*b*) The central small cells belong to the most remarkable elements yet described for the nervous system, and from the peculiar terminations of the axis-cylinder prolongations have been termed "basket-cells." They lie just ectad of the bodies of Purkinje's cells, are more numerous where these latter are more abundant, have their long axis in the plane of the cortical surface, and give rise to numerous and complicated protoplasmic prolongations, some of which may run almost to the surface of the cortex. The axis-cylinder prolongation is very long, runs in the plane of the surface, just above the bodies of the cells of Purkinje and in the neighborhood of each cell sends down a branch, which dividing into a bunch of terminals forms a net or "basket" about the cells. Of this very remarkable arrangement Kölliker expresses himself as perfectly satisfied.

This exhausts the classes of nerve-cells in the molecular layer, and we pass next to the *Granular Layer*. There are here distinguished large and small nerve-cells. (*a*) Large nerve-cells: These are characterized by being few in number, situated just below the molecular layer, having their protoplasmic prolongations distributed in both molecular and granular layers, and having the axis-cylinder prolongations of the second type, which have thus far been found, distributed in the granular layer alone. (*b*) Far more numerous than the foregoing are the small nerve-cells of this layer. These are furnished with short protoplasmic processes which end in bunches of terminals, suggesting in a distant way the terminations of the axis-cylinder branches in the "basket cells." The axis-cylinder prolongations on the other hand are slender,

long, arise as a rule from a protoplasmic prolongation at their base and pass without exception to the molecular layer, within which they divide into two branches running longitudinally and parallel to the surface; so abundant are these T-terminations in this region that a longitudinal vertical section of a folium shows a distinct longitudinal striation due to them.

Turning now to the *Nerve Fibres:* (*a*) The medullated fibres form a thick net-work in the granular layer, a thick band just below the cells of Purkinje, and bundles passing to the molecular layer between these cells. In the molecular layer they are abundant in the central portions and decrease towards the periphery. In this layer also they sometimes divide. (*b*) A portion of the fibres from the medullary layer are non-medullated, and end in part in the granular and in part in the molecular layer, and owing to the fewness of them in the latter locality they may be associated with the small peripheral nerve-cells of that region.

If the matter is looked at from the other side and we attempt to account for the nerve prolongations of the several groups of cells just described, we have the following:

Molecular Layer.—Cells of Purkinje, nerve prolongations medullated; (*a*) small peripheral cells, nerve prolongations not known; (*b*) basket-cells, nerve prolongations non-medullated. *Granular Layer.*—(*a*) Large nerve-cells, nerve prolongations non-medullated; (*b*) small nerve-cells, nerve prolongations medullated, giving rise to the bundles of nerve-fibres which pass between the cells of Purkinje and finally form the longitudinal striation of the molecular layer mentioned above(?) Nowhere is there seen anastomosis between the termini of cells or fibres either with themselves or with one-another, and the physiological relation remains therefore as much of a riddle as ever.

Zur feineren Anatomie des centralen Nerven-systems. Zweite Beitrag. Das Rücken-Mark. Taf. I—VI. A. KÖLLIKER. Zeitschr. f. Wissen. Zool., 51 Band, 1 Heft. Dec., 1890.

In this second communication Kölliker has formulated the new facts concerning the spinal cord much in the same manner as he has those for the cerebellum in the first communication just reviewed. The discoveries are the result of the application of Golgi's method to the nervous system of fœtuses or very young animals and the chief authorities, as before, are Golgi and Ramon y Cajal. In the material from immature animals the nerve-fibres are non-medullated to a greater or less extent, and appear therefore to be more easily brought out by the silver method. The fact that many of the results thus far obtained have not been verified on the adult by this same method may be urged against the validity of the conclusion, but other methods used on the adult give so much confirmation to the results here described that there is great reason for considering them as generally true.

In the light of these investigations the spinal cord in man may be described as follows:

The *dorsal nerve roots* all arise from the spinal ganglia, enter the dorsal column of the same side and there sooner or later divide into two branches one of which runs cephalad, the other caudad. In some cases these longitudinally coursing fibres run for a distance in the fœtus which would be equivalent to 4—6 cm. in the adult. In other cases they soon bend at right angles to the long axis and run into the gray matter, where they terminate. The criterion of termination is the formation of one or more finest branches, which in certain cases may amount to a bunch of terminals suggesting the "baskets of the baskets cells" in the cerebellum. In addition to these terminals there are those of an entirely new sort, formed by so-called "collateral fibres." These are very fine, arise more or less at right angles to the course of the main fibre, and appear too,

constantly abundant for these dorsal root fibres at least, and thus form a most important addition to the possible paths for incoming impulses. As many as nine of these collaterals have been counted running from a single fibre. The exact point in the fibre at which these collaterals arise in the adult is a matter of speculation. In the specimens described there appears to be a thickening of the fibre just at the point of origin, but the silver method does not offer any explanation of this appearance.

The dorsal roots pass to the dorsal columns and the gray substance of the same side, and to a small extent to the gray substance of the opposite, the crossing taking place mainly in the ventral commissure. The *efferent nerve roots* arise from the nerve prolongations of large and small cells in all parts of the ventral *cornua*, and in some cases give off at their origin a few branches. In many other cases no lateral branches are found, but the negative evidence in this case has little value. The ventral and lateral columns contain fibres which in part arise from cells situated at all levels in the cord. The great majority of fibres in these columns, if not all, give rise to collateral branches, which end freely in the ventral *cornua* and the ventral portion of the dorsal *cornua*. In many cases the fibres themselves of these columns bend at right angles and terminate as free fibres in the gray substance. The *ventral commissure* is composed, (*a*) of the nervous prolongations from cells in all parts of the gray matter which after crossing distribute themselves to the ventral and ventro-lateral columns, (*b*) of decussating collateral branches from the same columns, and (*c*) of decussating protoplasmic prolongations of some cells which lie close to the commissure. The *dorsal commissure* consists of (*a*) decussating collaterals of the dorsal root-fibres, (*b*) of possible decussation of collaterals from the dorsal portions of the lateral columns, and (*c*) doubtfully, of the decussation of the protoplasmic and nerve prolongations of a few cells lying near the central canal.

When the nerve-cells are classified on the basis of their nerve prolongations they fall into two groups: (*a*) Those whose nerve prolongation forms a fine net-work in the terminals of which it ends; and (*b*) those whose nerve prolongation maintains its identity, *i. e.* is directly continued into a nerve-fibre. Here again (*b*) a subdivision can be made into those that have nerve prolongations richly branched and those in which they are sparsely branched or not branched at all(?). When the cells are grouped according to the destination of the axis-cylinder they fall into: (*a*) Motor-cells where the nerve prolongation passes into motor nerve fibres and has the fewest lateral branches. (*b*) Those whose nerve prolongation passes into one of the columns of the cord and which may present almost any degree of branching. (*c*) Those whose axis-cylinder is much branched but in which the terminals are strictly confined to the gray matter of the cord. It will be noticed therefore that sensory cells in the older sense, are excluded from this list.

Passing by what may be said concerning the connective tissue elements we come to the physiological considerations connected with them. Those cells which directly give rise to nerve-fibres through their nerve prolongation alone act by continuity. In all other cases the relation between the nervous elements is that of contact simply, and constitutes an *actio in distans*. It was Golgi's view that the nerve prolongations ultimately formed a fine net work in which it was not so easy to see how an impulse should pick its way. The general outcome of Kölliker's discussion is that despite the great complication here present, there is a high degree of organization in this region and he rather swings back again to anatomical reasons for the reactions of the cord.

Striæ acusticæ und untere Schleife. Dr. C. v. Monakow. Archiv für Psychiatrie. Bd. XXII, H. I. Taf. I and II.

The author opens this paper, which is written with his usual care and precision, by a historical sketch of the views held regarding the *striæ acusticæ*, in which he specially dwells on those results which associate the *striæ* with the *lemniscus*. Passing to his own previous experiments he brings forward the following as bearing on the discussion. Removal of the entire temporal lobe, including the auditory centre of Munk, gave (in dogs?) degeneration of both cells and fibres in the *corpus geniculatum int.* of the operated side. This observation has been recently verified on two human brains where there was a defect in the temporal lobe. Moreover, following this operation, there was an evident degeneration of fibres in the arm of the posterior *corpora bigemina* on the operated side. If the lenticular nucleus and the *amygdala* were not also injured by the operation, then the degeneration could not be followed further caudad. In cats and rabbits, at least, the *inferior lemniscus* (*untere Schleife*) remains quite normal, after removal of the temporal lobe. If, in a rabbit, the caudal portion of the internal capsule be cut through, the atrophy in the *corpus geniculatum internum* and the arm of the posterior *corpora bigemina* is even more extensive than after removal of the temporal lobe, and in addition the nucleus of the posterior *corpora bigemina* is somewhat reduced in size. Neither the *inferior lemniscus* nor the so-called auditory nuclei are at all affected by this operation. In one instance, v. Monakow removed the posterior *corpus bigeminum* of one side, from a rabbit, and found as a result atrophy in the arm of the *corpus* and the *inferior lemniscus*, and also some loss of fibres in the ventral decussation of the *tegmentum*. When, however, the *inferior lemniscus* is sectioned in a new-born cat, there degenerate among other things the *striæ acusticæ* and the *tuberculum acusticum* of the side opposite that of the lesion. This result on the cat was obtained some time since, but the author has delayed publication until he could verify his results in some other case. Recently, a repetition of the same operation on a dog has given him similar results and he now publishes the account of both together.

The operation consisted in both cases of cutting the *inferior lemniscus* on the right side and observing the degenerations which followed. The details of the results must be omitted here, but the general outcome may be stated as follows: In a section just caudad of the posterior *corpora bigemina* are to be seen nearly all the bundles of fibres belonging to the *lemniscus*. This last—the *lemniscus* of Forel—occupies that region between the *pons* and *formatio reticularis*, which lies laterad to the *raphe*. The lateral portion of the region so bounded consists of fibres which in a cross-section are cut through squarely or obliquely, and is called the *inferior lemniscus*, lying for the most part laterad to the *formatio reticularis*. In the cat, v. Monakow divides the *lemniscus* of Forel into a lateral and mesal portion, the dividing line running parallel to the *raphe*, and cutting the *lemniscus* midway between the *raphe* and the mesal edge of the middle peduncle of the cerebellum. In each of these subdivisions he further distinguishes a dorsal and a ventral portion, which latter, however, are only separable in animals that have been operated upon. Of this area about two thirds belong to the so-called cortical *lemniscus—i. e.*, the fibres which degenerate upon removal of the parietal cortex, and they occupy the dorsal portion of both the mesal and lateral areas just mentioned. By "*inferior lemniscus*" v. Monakow designates the region between the ventral end of the superior cerebellar peduncle (*Bindearme*) and the gray matter of the *pons* and laterad to the *formatio reticularis*. In this region he marks off four areas, which he designates by *A*, *B*, *C* and *D* respectively: *A*, the central area, is the group of fibres which passes through and immediately

surrounds the lateral nucleus (Obersteiner) of the *lemniscus*. *B* is the ventral area which passes mesad into the so-called *lateral lemniscus* (v. Monakow's lateral division of the *lemniscus* of Forel). *C* is the dorsal area which occupies the space between the superior cerebellar peduncle and *A*. *D* is the mesal area of fibres, cut obliquely, which lies mesad of *A* and *B*, and is separated from them by a thin layer of gray matter.

Turning now to the results of the examination of the two animals experimented upon, they show that the dorsal area (*C*) when sectioned causes a degeneration of the dorsal fibres of the superior olive on the operated side, and of the arcuate fibres passing from this part of the superior olive to the dorsal surface of the other side. Since the fibres that take this course go directly to form the *striæ acusticæ*, it is, therefore, the *striæ acusticæ* which degenerate and in connection with them the large spindle-shaped cells lying in the dorsal portion of the *tuberculum acusticum*, so that this group of structures may be considered as physiologically associated. To this area (*C*) of the *inferior lemniscus* v. Monakow gives the designation of "Path of the *striæ acusticæ*" (*Antheil der Striæ Acusticæ*). It does not, however, contain *all* the fibres of the *striæ*, since some escape degeneration. Cephalad of the point of the initial lesion there occurs a degeneration in the gray substance of the posterior *bigemina*. Since, therefore, there are two sets of cells involved, in the *tuberculum acusticum* at one end, and the *corpora bigemina* at the other, v. Monakow assumes that two sets of fibres, conducting in opposite directions, have here been sectioned. Considering further the reactions of the posterior *corpora bigemina* to lesions lying cephalad to them, as given in the first part of this review, and now the reaction to a lesion lying caudad, the author suggests that there may be in their gray matter predominantly cells of the second or central type (Golgi), and that they may thus form an intermediate centre between the *medulla* and the cortex.

Dependent on the *inferior lemniscus*, according to these experiments, are the lateral nucleus of the *lemniscus*, and in part the superior olive, both on the same side as the lesion — further, the fibres passing ventromesad from the side of the lesion, and taking part in the ventral decussation of the *tegmentum* and the dorsal fibres (H_2) in the *regio subthalamica*, on the side opposite to the lesion. For the relations of these several degenerations to the areas of the *inferior lemniscus*, as above described, the reader is referred to the original.

V. Monakow's final statement with regard to the "Path of the *striæ acusticæ*" is that he considers these fibres as a secondary tract of the *acusticus* passing cephalad from the *tuberculum acusticum*, and at least once interrupted on its way to the cortex, the point of interruption being probably the gray matter of the posterior *corpora bigemina*; but what the connection between this intermediate centre and the cortex may be, is by no means clear from the experimental evidence at present available. The paper closes with a condensed statement of the relation of the author's views on the subject of the *striæ acusticæ* to those of Flechsig and Bagiusky. [It will be remembered that in his study of the path of the optic impressions (see AM. JOURN. PSYCHOL., Vol. II, p. 625), v. Monakow suggested the same arrangements of double sets of fibres conducting in opposite directions, which he here believes to exist in the "Path of the *striæ acusticæ*."—REV.]

La psicologia in rapporto alle ultime nozioni di fisiologia del cervello. L. BIANCHI. Estratto dagli Atti del IV Congresso tenutosi in Novara dall' 8 al 14 Septembre, 1889. Milano, 1890.

This paper is the report of an address given by Bianchi at the congress above mentioned, and is an example of the efforts now being made on many sides better to utilize the results of experimentation on the

brain for the benefit of psychology. The author urges the study of those phenomena in animals which may be grouped under the general term "changes of character." According to the observations most generally received, the ideational processes are dependent on the integrity of the sensory and motor cortical areas. The question is then asked whether the sense perceptions are due to a simple and elementary reaction of a cortical area, or are complex and based on the association of two or more cortical areas? The instances which the author then adduces from his own experiments and those of others favor the later view. Bianchi finds vision affected by lesions in the cephalic half of the cerebral hemisphere, in the dog, and the intensity of the disturbance increased as the lesion is carried further caudad. If the place of the excision affects only the amount of the disturbance, it is otherwise with stimulation, where the character of the reaction depends on the point stimulated. For example, the stimulation of the most cephalic portion of his (Bianchi's) cortical area produces closure of the eyelid; of the middle portion, movements of the eyeball; and of the most caudal portion, no movement. When this cephalic area is excised, there are no changes visible in the conjunctiva; yet, stimulation of the conjunctiva in dogs thus operated produces closure of the eyelid, as it would in a normal dog. He, therefore, infers, since the reaction can be gotten as described, after removal of the cortical centre, that when the reaction followed its stimulation it was not direct but due to the indirect excitation of the sensory cells of the visual area. Other instances are given where sensory disturbances follow the lesion of so-called motor areas, and it is concluded that the interruption of associative paths may explain these results. The author's next question is whether there may not be something over and above the sensory and motor centres which controls their action and gives capability for attention. From this point of view he finds, as others have done, dogs from which the extreme frontal cortex has been removed, very instructive. In such a case the animal appears intact, so far as sensation and motion are concerned, but in conduct he is highly deficient. This leads him to the tentative opinion that there is some relation between the completeness of the associative processes and attention and the lack of the latter in the animals in question is explained by the disturbance of the former. His final observation is on the variations in the character of different dogs from which the same amount of cortex has been removed from different regions, and here he obtains the classic results as described by Goltz in his earlier experiments.

The Principles of Psychology. WILLIAM JAMES. 2 Vols. New York, 1890. Henry Holt & Co.

The standpoint of any psychological treatise toward the anatomy and physiology of the nervous system is certainly of interest to those working along the latter lines. In these volumes there is almost no anatomy in the stricter sense of the term. The author's interests are on the physiological side, and certainly what he gives is most admirable. The nerve centres in the encephalon of the frog furnish the introduction to the whole subject, and the reactions of the animal, from the case where it is possessed of nothing but the spinal cord, through the intermediate cases up to the normal individual, are followed and described in accordance with the best results. The well-known scheme of Meynert, representing the child and the candle, and showing the nerve connection in the inexperienced child, who did burn his finger, as compared with the connections established in the same child when experience has acted on it, is used to lead up to the discussion of the education of the hemispheres. A brief allusion to phrenology furnishes here a useful preface, and is followed by as well proportioned a sketch of the history

of cerebral localization as is to be anywhere found. Naturally in such a book the latest results on some points, as for example, the recent observations on motor reactions from sensory areas (the visual and auditory centres), are overlooked; also the increasing evidence for a decidedly detailed projection of the retina in the visual area in dogs and monkeys, is not brought out. Neither these nor other minor omissions would seriously alter the general conclusions, however, and these latter are certainly drawn with due appreciation of the development and migration of function within the encephalon and the possibilities which that conception brings with it. Motion and sensation represented in the cerebrum; consciousness as the companion of nervous currents in the higher nerve centres, and associations between these centres themselves and the lower centres, furnish the background for the subsequent discussions. Since this conception is comprehensive, simple and highly plastic, it is easily handled in the more or less speculative chapters which follow, and it would be uncharitable to find fault with it. At the same time, there are those who long to get the problems discussed into the laboratory. For their purpose hypotheses must be rigid and anatomy detailed, so that while they will find these pages full of suggestion, they will not find the relations of brain function and brain form developed in a manner which permits of experimentation until both are more narrowly formulated.

The Origin of the Cerebral Cortex and the Homologies of the Optic-lobe Layers in the Lower Vertebrates. ISAAC NAKAGAWA. Journ. of Morphology. Vol. IV, No. I. July, 1890.

It was natural that Edinger's statement that the homolog of the cortex in the higher vertebrates could not be traced further down the scale than the reptiles, should stimulate a more careful study of the cerebral mantel in the amphibia. We have recently reviewed a paper by Oyarzun (AMER. JOUR. PSY., III, p. 377), coming from Edinger's laboratory, which shows that undoubted nerve cells are found in the mantels of several amphibia which were examined. Quite independently and in another way Nakagawa, working under the direction of H. F. Osborn, has compared the cells in the cerebral mantel in the Amphibia (*Rana, Menobranchus and Spelerpes*), the Reptilia (*Tropidonotus* and *Emys*), the Aves (*Columba*), and the Mammalia (*Didelphys*), and concludes that, though poorly developed, there is a layer of cells in the cerebral mantel of the Amphibia which must be considered the homolog of the cortex in the higher forms. In the first three classes the same method of comparison is applied to the several layers of the optic lobes, and from them a provisional scheme of the functional value of the various layers of this region is constructed.

Ueber früh erworbene Grosshirndefecte. Dr. v. MONAKOW. Correspondenz-Blatt für schweiz. Aerzte, Jahrg. XX, 1890.

Under this title v. Monakow briefly describes the brain of two young children in whom during the first month and first year respectively, a porencephalous condition developed which involved the region supplied by the *arteria fossæ Sylvii*. In both cases the lesion was on the left side of the brain. This area is that of the inferior frontal gyrus, the *operculum*, *insula*, and the first temporal gyrus, and the general point of his discussion is the relation which these portions of the hemispheres bear to the nuclei of the thalamus. Of special interest is the comparatively circumscribed degeneration of the *geniculatum internum*, which has not been described before for man and which the author associates with the defect in the temporal lobe, thus bringing his results here into harmony with those obtained by his experiments on animals. Whether the *geniculatum internum* is associated with the sense of hearing, must still be further investigated.

The Cerebral Cortex and its Work. HENRY MAUDSLEY. Mind. No. 58, April, 1890.

Those who may be interested in this line of thought will find a suggestive discussion in the above-mentioned paper, wherein the entire central nervous system is considered as an elaborate reflex apparatus. Sensory nerves are adapted for special stimuli, fit motor adjustment in response "is the fundamental quality of a perfect reflex action." Complexity of reaction is the criterion of a highly developed nervous system. The highest nerve centres are the store-houses of "adjustments and fit acts." Coming to the question of the motor centres of the cortex Maudsley asks "what actual relation of function the definite motor areas of the cortex have to the classes of movements which take place in consequence of their stimulation." He concludes, that it may be that no part of the so-called motor-region is really directly motor, but that it represents specialized movements, "abstracts of movement or motor abstracts, which are the efferent aspects of the cortical reflexes called thoughts." One corallary from this would be, no thought without movement.

Proceedings of the Physiological Society, 1890, No. IV, Journ. of Physiology, Vol. IX, No. 6.

Dr. Beevor gave a demonstration of the *cingulum*,—the longitudinal fibres of the *gyrus fornicatus*, and *gyrus hippocampi*—in the marmoset monkey. The most important general result was that the fibres forming the *cingulum* are not continuous from one end to the other, but are internuncial, running a short course in the *cingulum* and then turning out into the neighboring white matter. In that portion of the *cingulum* which lies dorsad of the *callosum* they thus appear to put the *gyrus fornicatus* in connection with the *centrum ovale*—an anatomical relation which is interesting in view of the observations of Schäfer and Horsley that removal of the *gyrus fornicatus* produces in monkeys tactile anæsthesia on the opposite side of the body.

Complete Sclerosis of Goll's Columns and Chronic Spinal Leptomeningitis with Degenerative Changes in the Fibres of the Anterior and Posterior Roots. F. W. MOTT, M. D. The Am. Journ. of the Medical Sciences. Vol. CI., No. I, Jan., 1891.

The case which the author describes was a male 46 years of age. His occupation exposed him to all weathers, and he drank rather heavily. History negative. He was admitted to Charing Cross Hospital on account of illness which had commenced some two years previously. He died, about twenty days after admission, of general tuberculosis of the lungs. The symptoms which are of interest in this connection were sudden failure of power in the legs, which increased until he lost completely the use of them, accompanied by pain, the legs becoming flexed and rigid. Weakness and wasting of the upper limbs developed later, but he did not completely lose the use of them. The reflexes were generally absent though a very faint knee-jerk was obtained on the right side. Sexual power was lost at the outset of the disease, but there was no difficulty in micturition or defecation. For the upper extremities the dermal sensations were normal. The only note on these sensations for the lower extremities is that tickling the soles of the feet was painful. The special senses and the movements of the muscles of the head and face were normal.

No note was made of the macroscopic appearance of the fresh cord. On sectioning the hardened cord the lumbar region was found free from degeneration up to the level of the first lumbar segment, but from this point to the cephalic portions of the cervical region the dorso-median columns were degenerated. The *dura* appeared normal but the *pia* was

the seat of a chronic *leptomeningitis* which caused a thickening and an encroachment of inflamed tissue on the periphery of the cord. Both dorsal and ventral nerve roots were extensively but irregularly degenerated, while the cells in the ventral *cornua*, in the column of Clarke, and in the spinal ganglia remained unaffected. The only other fibres found degenerated in the cord were scattered in the lower thoracic region in the dorso-lateral columns and in the mid-cervical region, located in the two wing-like masses, in the same columns. Inasmuch as the dorso-median column is sclerosed throughout and the initial lesion is assumed to be in the nerve roots between the cord and spinal ganglia, it is necessary to explain why this column alone is affected. The arteries of the sclerosed region have their walls enormously thickened, and the author suggests that it is possible to connect the sclerosis with the disturbance of nutrition thus indicated. He then quotes three cases of degeneration of the dorso-median columns in which the symptoms were somewhat similar to his own case and in two of which the muscular wasting was also observed. Before passing to the general conclusion it will be well to state what he assumes in the discussion, as expressed at the beginning of the paper. The fibres of the postero-median columns are formed from prolongations of the cells in the spinal ganglia and pass through the dorso-lateral columns on the way to their destination, but do not cross the middle line. It is probable that the fibres from the lumbar region become smaller in diameter as they ascend, for if a measured area of fibres in the lumbar region of this column be counted and a similar area, assumed to contain also fibres from the lumbar region, be counted in the cervical region, more fibres will be found in the second than in the first case. The fibres end in the post-pyramidal nucleus and, through the connections of this nucleus, in the cerebellum. The connection favors the idea that these fibres are paths for the muscle-sense, and the cases cited show that they do not conduct impulses connected with the sensations of touch, heat, cold or pain. Turning next to the conclusions which are based on the above statements and the cases given. They are in brief: 1. The dorso-median column may be connected with the transmission of impressions relating to the muscular sense or have some other function not yet determined. 2. The several cases given are similar in symptoms and reputed lesions. 3. The absence of knee-jerk, inability to stand, and wasting of the limbs, might be explained by lesion of the motor nerves which were more or less involved at their origin from the cord. Further, the disturbance might first express itself at the periphery in the motor end-plates, for though the nutritional disturbance might be too weak to affect the entire fibre it might show itself at the terminals which are furthest from the seat of nutrition. In the same way the complete destruction of the dorso-median column in the cervical region, while it is incompletely destroyed in the thoracic and lumbar regions (the fibres being considered continuous), is regarded as showing that the portions of the fibre most distant from the nutritive centre are most affected by the disturbance of nutrition. Further to support this view, idiopathic lateral sclerosis is mentioned.

[That the dorso-median column is connected with the cerebellum is a view far less well-supported than the current one, that its physiological continuation is in the arcuate fibres of the medulla. As regards their relation to the muscle-sense — in the author's case and two of those which he has cited, it is not stated that tests of the muscle-sense were made, and in the third case cited it is distinctly stated that the muscle-sense was normal. The motor phenomena can certainly be attributed to lesion of the motor elements and the view that nerves tend to degenerate at the point furthest removed from the nutritive centre, when the latter is affected, is, I believe, without experimental foundation.—REV.]

A Study of the Paths of Secondary Degeneration in a Case of Injury of the Cervical Spine. A. V. MEIGS, M. D. The Am. Journ. of the Med. Sciences. Aug. 1890. III Plates.

A blow on the back of the head and neck of a sailor caused loss of sensation and motion below the level of the clavicles. The patient died twenty-six days after admission to the hospital. The autopsy showed neither luxation nor fracture of the spine, but a small extra-dural hemorrhage into the spinal canal at the level of the seventh cervical vertebra. Specimens of the cord were taken from a little above this point and as far down as the lumbar region. The hardening was in Müller's fluid, and the staining, by carmine, Weigert's hæmatoxylin and Schultze's palladium and carmine method. This last was found to bring out an incipient stage of degeneration which the Weigert's hæmatoxylin did not reveal. At the level of greatest destruction (about the seventh cervical) the transverse myelitis appeared to involve the entire section, except the dorsal portion of the dorsal columns, and some peripheral parts of the ventro-lateral column on the right side. On completion of the hardening, the cord was examined macroscopically and the color markings used to locate the paths of degeneration. When, however, the paths thus located are compared with the indications from the microscopical examination, so much discrepancy is found that any direct inference from the one to the other is plainly unreliable at present. The macroscopic color changes are significant, but according to this account the possibilities of that significance have yet to be elaborated. The author calls attention to the distribution of the degeneration above and below the level of greatest disturbance. For example, above the level the dorsal columns are involved, whereas they appear normal at the point of the initial lesion. Below this level a region which appears to be that of the crossed pyramidal fibres is involved throughout the extent of the cord, but appears to have a less area in the mid-thoracic than at the levels above and below this. The peculiarity of this result is contrasted with the usual observation that as we pass from above downwards a lesion of this bundle gradually decreases until it fades out. For this appearance the author is inclined to fall back on some explanation other than the usual one, but for this and the several stages of degeneration in which the fibres were found, the reader is referred to the original.

The Presence of Ranvier's Constrictions in the Spinal Cord of Vertebrates Dr. WM. T. PORTER, Quart. Journ. Micros. Sci., Feb. 1890, 1 pl.

The author worked at Kiel in the laboratory of Prof. Flemming. The problem of the presence of the nodes of Ranvier in the fibres of the spinal cord was tested by him with silver, osmic, using the method of teasing and sections, on the cords of the rabbit, guinea-pig and ox, and nodes were satisfactorily demonstrated in all these animals, as his drawings show. The technical difficulties are apparently considerable and neither the distribution in the cord of any one animal nor in any large series of vertebrates was followed out, the author showing simply that the constrictions do exist in that locality in the animals named and that, as these fibres have no sheath of Schwann, the formation of these constrictions must be independent of that structure. Here and there since 1875 the existence of these constrictions in the spinal cord has been maintained, but the evidence here given appears to be the strongest that has yet been advanced. (The existence of these constrictions would harmonize with the "collateral" nerve branches of Ramon y Cajal, since they would give points at which these collaterals might leave the main fibre, thus bringing this new case under the law of branching as observed in the peripheral nerves. REV.

On the Progressive Paralysis of the Different Classes of Nerve-cells in the Superior Cervical Ganglion. J. N. LANGLEY and W. LEE DICKINSON, Proc. Roy. Soc., Vol. 47, March, 1890.

Pursuing their previous studies on the paralysis of the nerve-cells in the superior cervical ganglion by nicotin, (see review in AMERICAN JOURNAL OF PSYCHOLOGY, Vol. III. p. 372), the authors present in this paper evidence to show that the various effects of stimulation of the cervical sympathetic nerve are unequally influenced by the action of this drug, and therefore conclude that the different classes of nerve cells concerned, are not affected to the same extent at the same time. They worked with rabbits, cats and dogs, and the induction current was applied to the sympathetic nerve on the distal side of the ganglion so that the impulse must pass the ganglion to produce its effect. They recognize the following reactions upon stimulation of the nerve: (1), Retraction of the nictitating membrane; (2), Protrusion of the eyeball and opening of the eye; (3), Turning the eye (under certain conditions); (4), Dilation of the pupil; (5), Constriction of the small arteries of the ear, conjunctiva, and of various other parts of the head; (6), In the dog, dilation of the small arteries of the gums, lips and some other parts of the head; (7), Secretion of saliva. In making these experiments, the nicotin was given by intravenous injection, either in doses sufficient to abolish all the reactions from the sympathetic and then the order in which the various reactions returned upon recovery from the drug was noted; or the reverse process was pursued. Smaller doses being given, and the order in which the reactions were abolished, noted. The order of recovery was found to be the reverse of the order of paralysis. As bearing on the immediate question it may be repeated that Langley had previously found that in the cat the secretory cells on the course of the cervical sympathetic were more easily paralyzed than the secretory cells on the course of the *chorda tympani*; that in the dog the reverse was the case; finally that on the course of the *chorda tympani*, the cells associated with the secretory fibers were paralyzed before those associated with the vaso-dilator fibers. In the final tables the effects of stimulating the sympathetic are arranged for each animal,—rabbit, cat, dog,—in the order in which they disappear under nicotin. The absolute time intervals are short, not more than a few minutes as a rule, and many of the effects disappear apparently at the same time, but some of the effects are regularly abolished sooner than others. In the rabbit for example the withdrawal of the nictitating membrane disappears first and the constriction of the blood vessels of the ear last. In the cat the first is the secretion from the submaxillary gland, and the last, the withdrawal of the nictitating membrane. In the dog the dilation of the arteries of the bucco-facial region is first, and the last the constriction of the blood-vessels of the submaxillary gland. While the authors admit that tonic stimuli reaching the several regions by nerve fibers other than the sympathetic may influence their results, they nevertheless consider the differences in reaction just mentioned to be due to an unequal paralysing action of nicotin upon the nerve cells of the superior cervical ganglion.

Ueber den Nachweis der Unermüdlichkeit des Säugethiernerven. H. P. BOWDITCH. Archiv f. Anatomie und Physiologie, Physiol. Abthl. 1890.

In a previous investigation the author showed that prolonged stimulation of a motor nerve did not cause fatigue in it. The strength of stimulus was such as to tetanize the normal muscle with which the nerve was connected, and the muscle was then kept quiet by the action of curare while the stimulus was continuously acting on the nerve. On recovery from the curare the final tetanus was preceded by single

contractions of the muscle and then an imperfect tetanus. This paper bears on the question whether these first reactions of the recovering muscle are due to changes in the muscle or in the nerve during the experiment. The work was done on dogs and the simple method was used of comparing the reaction of the muscles on recovery from curare first, when the nerve was continuously stimulated during the interval preceding recovery and next when it was not so stimulated. Under both conditions the muscle reacted in the same way, and it was therefore concluded that the peculiar reactions were independent of any changes in the nerve due to stimulation, and were muscle phenomena only.

Twelve Lectures on the Structure of the Central Nervous System, for Physicians and Students. By DR. LUDWIG EDINGER. Second revised edition, with 133 illustrations, pp. 230. Translated by W. H. Vittum, M. D., edited by C. Eugene Riggs, M. D. Philadelphia and London. F. A. Davis, 1890.

It has long been felt among those interested in these matters that a translation of the "*Zehn Vorlesungen*," or as it was rechristened in the second edition "*Zwölf Vorlesungen*," of Edinger would facilitate instruction in the finer anatomy of the nervous system in this country. The gentlemen who have made the English version have been conservative in all matters. The nomenclature is that of the English anatomies. No notes are added to the original, and the same illustrations appear in the English that are to be found in the German edition. The English book has more pages owing to the use of larger type and a somewhat smaller page. The contents of Edinger's original book is already familiar and it needs only to be added that the second edition contains some results of the author's studies in the comparative anatomy of the brain, especially that of the fibre tracts; these results have on several occasions been reviewed in this JOURNAL. This translation forms probably as compact, consecutive and practically useful a treatment of the subject as we have in English.

Macroscopic Vocabulary of the Brain with Synonyms and References. Prof. B. G. WILDER.

This pamphlet, which appears so far as we can judge *sumptibus auctoris*, was presented at the last meeting of the Association of American Anatomists held in Boston, Dec. 29, 1890. It contains something over 200 terms which the author recommends for use in the macroscopic description of the brain. They are for the most part mononymic paronyms (*i. e.* words adopted into a modern language without essential change) arranged in alphabetical order and followed by references to standard publications where they are defined by use.

II.—PSYCHIATRY.

RECENT LITERATURE OF GENERAL PARALYSIS.

BY WILLIAM NOYES, M. D.

PRODROMAL STAGE AND EARLY DIAGNOSIS.

The Early Stage of General Paralysis. CHARLES F. FOLSOM, M. D. Transactions of the Association of American Physicians, September, 1889, and the Boston Medical and Surgical Journal, 1889, CXXI, p. 349.

Dr. Folsom's article deals with a stage of general paralysis that has been very little touched on in the books; and the asylum physician rarely,

if ever, sees cases presenting the symptoms here described. The body of the article is a most careful and painstaking analysis of seventeen cases selected with reference to giving the most important points in diagnosis, in which the symptoms preceded by varying periods the time that is usually looked on as the beginning of the disease. A careful study of the cases themselves is necessary for a full appreciation of the obscure and insidious character of the first symptoms, but Folsom's description of the general mental condition in this early stage furnishes an excellent clinical picture of this state. It cannot well be summarized, and its importance warrants giving it in full.

"The question whether the diagnosis of general paralysis can be made in its actual incipiency is still under judgment; I do not know an instance where it has been successful. Indeed it is not within my experience that a physician has been consulted so early. The absence of subjective symptoms and the lack of those naturally observed by others, as compared with the various forms of neurasthenia, for instance, are quite deceptive. But the change in personal traits or character, and the peculiar apathetic, indifferent, unconscious quality of the mental impairment, in uncomplicated cases, are unlike anything else. There is not the slightest doubt, however, that general paralysis can be diagnosticated with certainty far oftener than not, for a considerable length of time before what is usual now. It is quite true that the signs of mental impairment may be ascertained only by a painstaking examination, that the patient may bear cross-questioning without manifesting any degree of loss of those finer qualities of brain, psychic and motor, coming last in a highly organized and developed civilization, although it may at the same time be detected by the methods which I have suggested. The very essence and nature of general paralysis imply and involve mental symptoms in some degree, and some motor impairment, however slight, even if only judged by the test of a minute examination of what the patient can do and how well or how ill he does it. The symptoms may thus be recognized in a large proportion of cases, and at least suspected in most, certainly in those persons whose brains are so highly organized, who are so trained and cultivated that slight changes in the highest brain-centres produce distinct, although difficultly appreciated, departure from their normal character and quality of mind. In an orchestral leader, for instance, the mental and fine mechanical operations are so complex and of such high order that the least fault is detected; in professional and business men a less degree of impairment is recognizable than in mechanics; in routine employments without much thought or nice muscular effort, a large degree of deterioration may be unnoticed. In day laborers an early diagnosis is simply impossible.

"The earliest signs of general paralysis are of the slightest possible brain failure; if, for example, a strong healthy man, in or near the prime of life, distinctly not of the "nervous," neurotic or neurasthenic type, shows some loss of interest in his affairs, or impaired faculty of attending to them; if he becomes varyingly absent-minded, heedless, indifferent, negligent, apathetic, inconsiderate, and although able to follow his routine duties, his ability to take up new work is, no matter how little, diminished; if he can less well command mental attention and concentration, conception, perception, reflection, judgment; if there is an unwonted lack of initiative, and if exertion causes unwonted mental and physical fatigue; if the emotions are intensified and easily change, or are excited easily from trifling causes; if the sexual instinct is not reasonably controlled; if the finer feelings are even slightly blunted; if the person in question regards with a placid apathy his own acts of indifference and irritability and their consequences, and especially if at times he sees himself in his true light and suddenly again fails to do so; if any symptoms of cerebral vaso-motor dis-

turbance are noticed, however vague or variable. Naturally there may be many or few of these indications in a given person. This group of symptoms seems very striking, but may be compatible with the performance of usual duties. They require careful and prolonged observations of the patient, and painstaking interrogation of his family and friends for their detection. They are recognized perhaps as much from the peculiar mental quality of the mental impairment, difficult to describe, as from its degree, and often ante-date, at least in the time of their recognition, perhaps not absolutely, any physical symptoms, which when they appear, may be so slight as not to be appreciated for a long time, except as an unusual sense of weariness on exertion, and perhaps attributed to malaria or rheumatism. Commonly there is loss of flesh, slight, moderate, or excessive. A very great or disproportionate loss of physical power, especially in the legs, I have found to be due to a complicating peripheral neuritis. We must not overlook the facts that there are elements of uncertainty in the early diagnosis of general paralysis, that there are few forms of mental disease in adult life that it may not simulate in obscure cases, and that it may be confounded with Bright's disease, epilepsy, hysteria, lead or malarial poisoning, cerebral syphilis, or the long-continued abuse of opium, alcohol, chloral, and the bromides, so that not seldom an absolute early diagnosis is impossible. But there is a peculiar, indescribable form of mental impairment which, with the vague physical deterioration, if not obscured by other conditions, may be sufficient to decide the diagnosis. Even the expression of the face and the general appearance of the patient are often characteristic. There may or may not be slight confusion, a sense of fullness in the head, headache, insomnia. Except for unusual physical as well as mental fatigue following effort, the patient may feel entirely well and not complain of anything. There is no indication from the eyes or reflexes so early; the muscular tremor is, as a rule, less than in functional nervous disorders; the speech may be not noticeably affected to the family, and may be only like that of a person with lips chilled by frost or slightly under the influence of wine. It may be necessary to have the patient read or copy several pages or even be under close observation for several days before any defect is observed in the use of the muscles, or it may be necessary to test him in a new place or occupy him in unaccustomed ways. Finally, perhaps the distinguishing feature of this stage of general paralysis is the fact that the change observed consists in a symmetrical mental and physical deterioration which, like all diseases in which a vaso-motor element is prominent, varies very much from time to time. It begins, or is first noticed, in those acts requiring the most complicated and highly coördinated effort, in the functions and powers coming last in development of the highly organized and trained brain. As the mind becomes decidedly less able and the muscles less responsive, with less coördinating power, and finally weaker, the heavy and then staggering gait, the hesitating, stuttering and finally unintelligible speech, and the progressive dementia, may be slow or rapid in their advance.

"The prognosis of the pronounced general paralysis of the books is so unfavorable that there are only exceptional remissions of the symptoms, which last so long as to justify a few writers in calling them cures. Early symptoms, however, which in men of forty years of age, so far as we now know, almost certainly mean death, when occurring in men of sixty are not incompatible with a fair recovery. In the stage of general paralysis that I have attempted to describe, it is true that there have been thus far only partial recoveries. But the indications are that a certain proportion of cures may be expected with more satisfactory treatment. The treatment of general paralysis has thus far been most unsatisfactory from the fact that it is begun only very late; because a

rest of a few months often brings such relief that further treatment is abandoned; because a remission which may naturally come in the course of the malady is too apt to satisfy the patient or the friends that the disease is at an end; and because our therapeutic measures have thus far proved, as a rule, so ineffective that we cannot often get our patients to consent to a great sacrifice of time and money, and all that goes with it, for a cure that at best may mean only comfortable uselessness for many years. The travelling or stimulating life usually suggested ends in aggravation of symptoms. Entire mental rest in a quiet place in a sedative climate, with simple food, abundance of sleep and moderate exercise, results in such improvement that there is every reason to suppose that such measures, if fully carried out, might do more."

PATHOLOGY.

Die pathologische Anatomie der Dementia paralytica. E. MENDEL. Neurologisches Centralblatt, 1890, No. 17, p. 519.

In the section for Neurology and Psychiatry of the Tenth International Congress Prof. Mendel gave a review of the present condition of the pathology of *Dementia paralytica*. The extended and careful researches of the last ten years lead him to think that further light on this subject cannot be expected, at least from the methods of investigation at present at command. He passes over without consideration all the changes in the skull, dura and pia about which there is no dispute, as well as the gross anatomical relations, such as atrophy of the convolutions and diminution in brain weight, and considers only the results of the microscopical examination of the brain.

The Neuroglia. Increase of the nuclei is a very common occurrence. The spider-cells also frequently show a great increase and extension. In this connection Golgi's staining has given especially beautiful results. Nuclei as well as spider-cells are present in normal brains, but in smaller numbers, and the last only of very small dimensions, while in general paralysis they exceed the normal size three or four times, or even more. In the normal brain spider-cells are mostly clearly seen only under the surface of the brain, while in general paralysis they are scattered throughout the entire thickness of the cortex. This last condition is also sometimes found in the neighborhood of encephalitic deposits and syphilitic neoplasms, but in these cases only in circumscribed places, while in paralysis it is more extended in the frontal and parietal lobes, especially in the central convolutions, and also in the basal portions of the frontal lobes. It is this spider-cell development which, pushing its way through the white substance, finally comes out on the exposure of ventricles as ependyma proliferation. The brain substance in long continued cases finally falls away in a confusion of fibres: sclerosis; if this process is strongly developed in the medullary laminæ, especially if the autopsy is made somewhat long after death, and the cortex has undergone a slight post mortem softening, the cortex can be separated from the medullary substance with the back of the scalpel, as Baillarger, Rey and Tuczek have pointed out. The separation as a rule takes place in the cortex itself, so that pieces of this remain attached to the medullary substance.

The Vessels. The larger brain vessels in general paralysis are more frequently intact, or show only a trifling amount of change, at times being more or less atheromatous. With the present methods of investigation it is in many cases difficult to say anything accurate and trustworthy of the condition of the small arteries and capillaries which lie in the ground substance. Notwithstanding this, however, it has been possible hitherto in most cases of paralysis to point out certain morbid changes in the vessels: increase of the nuclei in the vessel walls and

perivascular spaces, which Weidl observed as far back as 1859, miliary aneurisms, widened spindle-form adventitial spaces, etc. Here belongs also, as a widening of the lymph spaces, the cystoid degeneration so often found in general paralysis. Further changes in the vessel walls are the colloid and hyaloid degenerations described by Grieff and lately by Dagonet. All these changes occur also in other forms of brain disease, they have nothing characteristic of general paralysis, but it seems clear that with better means of investigation their *regular occurrence* in general paralysis can be shown.

The Ganglion Cells. At the session of the society of German Alienists in Berlin in 1883, Mendel took the ground, against strong opposition, that changes in the ganglion cells were an almost regular occurrence in general paralysis, and now the views of authors are almost unanimous that changes in the ganglion cells may always, or at least almost always be observed. Nissl's staining has materially advanced knowledge in this direction. A description of these changes was given by Mendel in 1884 (*Neurolog. Centralbl.*, 1884, p. 487). Widening of the pericellular spaces, changes in the protoplasm such as fatty pigment degeneration, sclerosis and atrophy of the cells (hyaline degeneration of Liebmann), changes in the nuclei such as shrinking or enlargement, are the usually reported findings. These changes are especially marked in the frontal lobes, on their lateral and medial surfaces, as well as on their lower; also in the parietal lobes, and least in the occipital lobes. Normal cells often lie between the altered ones. Similarly altered cells are also observed in other pathological processes of the brain.

The Nerve Fibres. To Tuczek belongs the credit of first calling attention in 1883 to the atrophy of medullated nerve-fibres in the cortex of paralytics. A large series of observations has been made in this direction with the following results: 1. The shrinking of the nerve-fibres in general paralysis is not confined to the cortex alone, but takes place throughout the entire brain. The nerve atrophy in the cortex is thus only one part of a process affecting the entire medulla of the brain and cerebellum. 2. This fibre-atrophy, especially the cortical, occurs not simply in progressive paralysis, but also in epilepsy, senile dementia, alcoholic paranoia, etc. Finally, reference may be made to the alteration of the nuclei of the brain nerves and to the degeneration of the peripheral nerves. With regard to the cord, this is normal in a number of cases of general paralysis, but in the great majority of cases it also is diseased. The changes that show themselves are: 1. Isolated gray degeneration of the posterior columns. 2. Isolated degeneration of the pyramidal tracts. 3. Disease of the pyramidal and cerebellar tracts with intact posterior columns. 4. Various combinations of diseases in different tracts.

From the anatomical findings described it is evident that no individual one of these morbid changes, either in the neuroglia, in the vessels, in the ganglion cells, or in the nerve fibres, is in and by itself characteristic of general paralysis; its essential difference from all other brain diseases lies not in the special changes, but in the diffuseness of the process, which appears spread over a great part of the cortex—sometimes over its whole extent, and even over the cerebellum, and taking all these facts into consideration we are justified in looking on general paralysis as a disease *sui generis*. In this it is self-evident that the clinical picture must vary according as the development is acute or chronic, according to the greater or less extension and according to the complications with other affections. The more closely and carefully the examination is made, the more are the frequent early negative reports of the microscopic examination invalidated, and now it can only rarely be asserted that in a well-marked case of general paralysis that has lasted a long

time there are not the characteristic findings in the neuroglia, the vessels, the ganglion cells, and the nerve fibres.

Up to this point Mendel's views are in essential accord with those of most alienists, but there is a dispute as soon as the question arises as to where the starting point of the morbid changes is to be sought. Regarding this there are two views directly opposed to one another. The first is that the starting point is a primary degeneration of the nerve fibres, and that the disease of the vessels, the neuroglia and the ganglion cells is secondary; the second view is that the process starts in the vessels, and that an inflammatory process proceeds from these to the neuroglia, the inflammatory products leading to the destruction of the nerve fibres and to changes in the ganglion cells. If it were oftener possible to study very rapidly developing cases of general paralysis—the diagnosis, however, must be absolutely certain—a decision might possibly soon be reached. There is, however, only a small number of such observations. In one case in which there was an early autopsy Greppin found no atrophy of the nerve fibres, while Friedmann, in a case of a little over two months duration, found pronounced changes in the vessels. Mendel is able to report a second such case. These cases, therefore, tell against primary degeneration.

Mendel's assistant, Kronthal, by a special procedure was able to isolate the capillaries in the fresh brain, and in all the cases of general paralysis studied by this method there is shown a great degree of widening of the capillaries, thickening of their walls, and a marked increase of nuclei in these. This speaks still farther for the primary involvement of the vessels. Where all the different elements have been changed by disease, the relation between the atrophy of the nerve fibres and the changes in the vessels is a very varying one; sometimes the changes are relatively proportional, while again one and then another predominates. Under these circumstances it would seem that we could not come to a fixed conclusion with regard to the starting point in men. For this reason Mendel in 1883 undertook experiments to produce in dogs a disease similar to *dementia paralytica* in men. The experiments were repeated with similar results by Lemos, Kusznezow and Fürstner; the last makes the similarity to human paralysis more evident since he finds also in the paralytic dogs disease of the cord and optic nerve atrophy. At the time of Mendel's first experiments the finer methods for the recognition of nerve fibres did not exist, but he has recently gone over the experiments again, directing special attention to how in beginning disease the morbid process first showed itself in the brain; the dogs were therefore killed when they showed the first sure signs of disease. The following are the results of the microscopic examination: Changes in the vessel walls through numerous scattered nuclei, widening of the adventitial spaces, in which numerous nuclei are visible, but *no changes in the medulated fibres and no changes in the ganglion cells.* In dogs, therefore, the disease certainly acts not as a primary degeneration, but as an inflammatory process proceeding from the vessels. To carry a physiological experiment directly over to man, especially in mental diseases, certainly has something misleading, yet we cannot abstain from doing this in doubtful cases. One point from the symptomatology of general paralysis is of importance with regard to this question. In a great number of cases fainting attacks precede the outbreak of the mental disease, and also apoplectiform attacks, conditions which are referred to stagnation in the vascular system. Here then are some changes present at a time when there is absolutely no reason for assuming an atrophy of the fibres. Finally, the conclusion that appears to Mendel justified at this time, even if it cannot be proved with absolute certainty, is that in general paralysis there is first present disease of the vessel walls through hyperæmic stasis in the vessels; exodus of

blood corpuscles and inflammation of the neuroglia follows, leading secondarily to destruction of the nerve elements. General paralysis, then, may be designated as *a diffuse interstitial encephalitis, terminating in brain atrophy.*

Zur pathologischen Anatomie der Dementia paralytica. LUDWIG MEYER. Neurologisches Centralbl., 1890, No. 20, p. 610.

This is a criticism of certain points in the preceding article by Mendel, citing the conclusions that general paralysis is a diffuse interstitial encephalitis, and the conclusions on the microscopic examination of the brain of the dogs. Meyer claims that essentially the same findings have been shown by him to exist in a considerable number of cases, and since Mendel casts doubt on the significance of these observations, either through doubt as to the diagnosis or because of the small number of cases, Meyer reviews his own contributions to the subject of *dementia paralytica* extending over a number of years. In 1858 he claims to have advanced proof that in typical cases the disease takes its course in febrile exacerbations, and may therefore be classed with the chronic febrile diseases as a meningo-encephalitis. The anatomical proof of this was published in the *Centralbl. für med. Wiss.*, 1867, Nos. 8 and 9. The accumulation of the nuclei and cells in the walls of vessels was described, and the change of the ganglion cells in atrophic brains was described as a result of vascular degeneration. Meyer agrees with Mendel that the question of the primary changes can only be settled by a study of those cases with a very rapid development; but this rapidity must without doubt be looked on suspiciously, for since "the diagnosis must be absolutely certain" it is necessary that the time of development as well as of the existence of the typical symptoms should not be too short. Meyer claims that with the limitations just mentioned he has given the essential anatomical changes of the disease in his work on the Pathological Anatomy of Dementia Paralytica (*Virchow's Archiv*, 1873, pp. 270–303.) As far back as then he said "only those changes in the brain can be looked on as pathological which appear and are constantly observed with the first distinct symptoms of disease," and "cases of very short course must serve exclusively as the basis for investigation." "Brains with appearances of atrophy must be excluded, or must be admitted only with great reservation." Meyer found 20 cases answering these conditions; and among other things, the normal brain weights went to indicate that the cases fulfilled the required conditions; and these were further strengthened by some of the phenomena of the course which resembled a severe meningitis, or there were headaches in the beginning, maniacal outbreaks resembling febile delirium, convulsions, paralytic attacks, etc. In all the cases there were early autopsies. There was cell-proliferation of the vessel walls. Meyer's conclusion at that time was that, apart from the chronic meningitis which was not always present, the changes at the beginning of the disease were confined to these vascular changes, which were claimed to be inflammatory. Examination of the substance of the brain gave an entirely negative result.

MANNER OF DEATH.

De la mort dans la paralysie générale. JEAN L. BARAZER. Thèse de Paris, 1890, No. 179.

Barazer considers that the question of the mode of death in general paralysis may be reduced to simpler proportions than in Jamin's thesis of 1887. If it is true that the causes of death may be innumerable, it is also incontestable that the patients always die, or at least almost

always, in the same manner, and that all the cases of death, with almost no exceptions, may come under the general primary disease.

The forms of death are as follows:

a. By the direct manner.
- Apoplectiform attacks.
- Epileptiform "
- Maniacal excitement.
- Vices of nutrition and trophic troubles. — Paralytic; Marasmus and Bed-sores.

b. By the indirect manner. } But intimately related to
c. By accidental causes. } the cerebral lesion.

The natural form of death is by marasmus or paralytic wasting. This is the natural termination of the disease and also the most frequent, other forms of death being only complications. Christian and Ritti found this manner of death in 52 out of 119 men, and in 9 out of 20 women. The author adopts Charcot's theory of the central origin of *decubitus acutus*.

COMPLICATIONS.

Contribution à l'étude du mal perforant dans la paralysie générale. HILDEVERT BERTHÉLEMY. Thèse de Paris, 1890, No. 126.

The author considers historically the question of the origin of perforating ulcer of the foot, and of the three theories as to its origin, the mechanical, the vascular, and the nervous theories, he favors the latter, claiming that the nervous lesion is always present, while the vascular changes may be absent. Perforating ulcer is usually considered a rare complication in general paralysis, but Berthélemy claims that it is not so rare as is supposed, and that published observations are so few because attention has not been sufficiently called to the condition, and he is able to present eighteen observations, all from French sources, four being personal. In two cases the patients had suffered from a preceding locomotor ataxia, and the combined action of the tabes and the general paralysis producing the ulcer is admitted, while in two other cases alcoholism was doubtless a similar causal factor, but in the remaining fourteen there was no complication, and the general paralysis was looked on as the direct cause of the ulcer. A striking fact brought out in the study of the cases was that in eight of the eighteen cases it was noticed that under the evident influence of the ulcer undoubted remission occurred in the course of the general paralysis. The same fact was noted by Christian in publishing his observations on *mal perforant* in 1882, and he claimed that almost all remissions in general paralysis came as a sequel of prolonged suppurations. Berthélemy suggests that such remissions following suppurations give a basis for the therapeutic employment of revulsive measures such as setons in the neck or the actual cautery. The author reaches the same general conclusions as Marandon de Montyel in his thesis of 1888:—1. Progressive general paralysis is as justly a cause of perforating ulcer as other diseases of the nervous system. 2. The infrequency of published observations on perforating ulcer point to the fact that the complication should be carefully looked for to be discovered, and that attention has not been sufficiently called to it. 3. Perforating ulcer shows itself by preference in those general paralytics who have been alcoholics, or who have at least had some excess in drinking. 4. Perforating ulcer, judging by those cases which we have at command at present, favors remissions in general paralysis in those paralytics who have it.

The Pulmonitis of Paralytics and Degeneration of the Vagi Nerves. Dr. BIANCHI. Translated and abstracted by Joseph Workman, M. D. Montreal Medical Journal, 1889–90, XVIII, p. 481.

Bianchi is unable to attach any very great importance to the forms of pneumonia studied by him in the insane, accompanied by more or less advanced degeneration of the pneumogastrics. As slight compression, from which the tissues in their normal condition feel nothing, produces a bed-sore when a neuritis or an inflammatory process exists in the spinal cord, so a degenerative neuritis changes the conditions of nutrition in the pulmonary parenchyma, and in these altered conditions stimuli which were previously harmless may become pathogenic, reaching the lungs through the larynx, the mouth or the tracheal tube in the inspired air. Hyperæmia, if it is present, the disturbed respiratory mechanism, increased endoalveolar pressure, paralysis of the muscular fibres of the bronchi, insensibility of the mucosa of the deep respiratory passages, are but so many factors concurring to disturb the process of nutrition. Even gangrene, which is so common a finding in the pulmonitis of paralytics, simply indicates the frail vitality of the tissue, and preceding lesions in the vessel walls may have contributed in determining the easy and prompt death of the tissue, however slightly more intense may have been the stimulus which it has been unable to resist.

Case of General Paralysis Complicated by Aphasia. C. P. TANNER, M. D. Brain, 1890, XIII, p. 111.

Male, aged 33. A typical case of general paralysis with a sudden onset, beginning to talk "jargon" while reading; shortly afterwards right arm and leg were paralyzed; unconscious for four days; on recovery his language was entirely incomprehensible. Disease began at least a year before. A month after admission could not understand spoken words, except his name; could not read printing aloud; could not repeat spoken words, write at dictation, or copy printed matter. Could understand written words to a fair extent, and read them aloud, but made mistakes in pronunciation of letters, *e. g.* called *name*, *tame*. In copying, frequently transposed letters, but put them all in. Further history was the ordinary one of general paralysis. Examination of brain, besides the usual symptoms of general paralysis showed whole of left insula destroyed, apparently result of hemorrhage, its place being occupied by a broken down blood-clot, apparently encysted. Hemorrhage had invaded first tempero-sphenoidal lobe near its tip, and also part of the inferior parietal lobe, adjacent to fissure of Sylvius. Claustrum destroyed, external capsule, lenticular nucleus and internal capsule flattened in direction of lateral ventricle. Source of hemorrhage not found.

OCULAR SYMPTOMS.

The Analysis of the Motor Symptoms and Conditions of the Ocular Apparatus, as observed in Imbecility, Epilepsy, and the Second Stage of General Paralysis. C. A. OLIVER, M. D. American Journal of the Medical Sciences, 1890, c, p. 486.

Conclusions: 1. In idiopathic epilepsy of the male adult, even when the stage of dementia has been reached, both the intra-ocular and the extra-ocular motor groupings seemingly, as a rule, remain unimpaired, both as to innervation and to active impulse, although in some instances curious enervations and limitations of action seem to exist. 2. In the lower grades of imbecility, as seen in the male adult, which have resulted from malformation or disease of a minor degree than that producing so called idiocy, that have supervened in infancy or

occurred before birth, both the intra-ocular and the extra-ocular muscle-groupings, as a rule, remain unaffected both as to innervation and as to proper action; in fact they seem ordinarily to retain their original condition without any pronounced indications of wear and tear; a condition that most probably evidences very little abuse of a delicately poised muscular apparatus. 3. In the second stage of paresis, as seen in the male, both the intra-ocular and the extra-ocular motor-groupings are in all instances more or less paretic, as evidenced by great inequalities and irregularities of pupillary areas, with peculiarities in iritic movement and loss in ciliary tone and power, as well as by extra-ocular insufficiencies and ataxic nystagmic motions, all indicative of imperfect muscle-innervation and inadequate muscle-action.

An Analysis of the Ocular Symptoms found in the Third Stage of General Paralysis of the Insane. By C. A. OLIVER, M. D. Medical News, 1890, lvii., p. 287.

Each subject was seemingly free from any gross extraneous disease or local disorder, and discretion was exercised that authoritative medical opinion had been given as to the type and stage of the general complaint; the study was limited to the male sex. In a disease of such complex symtomatology, where doubtless quite a number of pathological peculiarities exist at one time, accurate pathognomonic changes cannot be expected in each case, and for this reason a great number of seemingly similar cases were studied to obtain an idiocratic picture of the oculo-motor and retinal changes. A study of 32 cases gives the following conclusions:

1. The oculo-motor symptoms of the third stage of General Paralysis, which consist in varying, though marked, degrees of loss and enfeeblement of iris response to light stimulus, accommodative effect and converging power; lessening of ciliary muscle tone and action; weakening and inefficiency of extra-ocular muscle motion,—all show paretic and paralytic disturbances connected with the oculo-motor apparatus itself, of greater amount and more serious consequence than those seen in the second stage of the disease.

2. The sensory changes in the third stage of General Paralysis, which, though similar to those found in the second stage of the disorder, are so pronounced as to show a semi-atrophic condition of the optic nerve head, and marked reduction in the amount of both optic nerve and retinal circulation, with consequent lowering of centric and excentric vision for both form and color—all indicate a degenerate condition of the sensory portion of the ocular apparatus, with impairment of sensory nerve action.

3. The peculiar local changes seen in these cases, which consist in conditions of the choroid and retina, indicative of local disturbance and irritation of these tunics, more pronounced than those seen during the second stage of the disease—all represent the results of greater wear and tear given to a more delicate and more weakened organ.

4. Both the motor symptoms and the sensory changes of the ocular apparatus, as thus described in the advanced or third stage of General Paralysis, furnish not only evidences of a local disturbance of a more pronounced type than those shown in the second stage of the disorder, but plainly show themselves as one of the many peripheral expressions of fast approaching degeneration and dissolution of nerve elements, most probably connected with related cortex-disintegration and death.

Note on Optic Nerve Atrophy preceding the Mental Symptoms in General Paralysis of the Insane. By JOSEPH WIGGLESWORTH, M. D. Journal of Mental Science, 1890, XXXV, p. 389.

In a previous communication (*Brain*, 1884), Wigglesworth and Bick-

erton have shown that in 66 cases of General Paralysis the *fundus oculi* was normal in a majority of cases, but in a considerable minority there were changes in the direction of *neuritis* or atrophy; and while optic atrophy was noted as a sequel of *neuritis*, it was also not infrequently primary at the disc. In all these cases the changes in the disc had developed after the mental symptoms; but one case was quoted from Nettleship where optic nerve atrophy preceded the symptoms of the disease. Wigglesworth is now able to add a second case of this kind, where the patient had to give up work from blindness three years before any mental symptoms developed. There was well marked gray atrophy of both discs, the vessels, however, not being obviously shrunken. At the post-mortem both optic nerves were much shrunken. Making all due allowance for the fact that the mental symptoms may have existed for some time before they became apparent to the wife, it still seems clear that the optic atrophy was the primary feature. [Folsom, in the article cited at the beginning of these reviews, found in one of his cases, Case VIII, in the prodromal stage, beginning atrophy of the optic disc —the only case where he had ever found it except at a late stage.— REV.]

ALLEGED RECOVERIES.

Fall von Dementia paralytica mit Uebergang in Genesung. DR. WENDT. Allgem. Zeitschr. f. Psychiatrie, 1889, Bd. XLVI, H. 1, S. 77.

Dr. Wendt's case was presented before the 64th Session of the Psychiatric Union of Berlin, Dec. 14, 1888. The patient was a physician, had spent 6 1-2 years in an asylum, and on his discharge had resumed practice and had been a district surgeon for 7 years. Wendt had had him under observation for 3 1-2 years in the asylum. All the physicians who had had charge of him agreed in the diagnosis of general paralysis. When admitted to the asylum in 1872, he was 43 years old; little was known of his life, but there was no history of excesses. Two paternal uncles died in an asylum, and his only living brother was "weak-minded." The prodromal period extended back three years. Ataxic gait, immobile pupils, delusions of grandeur, and weakness of memory, were noted on admission. The history showed the usual symptoms of general paralysis, and his letters would be looked on as typical of the disease, with the customary grandiose ideas, unsteadiness of writing, and omission of words and syllables. From June 1872 to the end of 1874 the disease appears to have been at its height, and had continued without remissions and without essential increase of the characteristic symptoms, and especially of the motor symptoms. These symptoms then receded, and when Wendt took charge of the institution in July 1875, there was an entirely different clinical picture. The motor symptoms had disappeared; gait and standing were steady and firm, and the articulation undisturbed; pupils equal and reacted well. Writing was now and then unsteady, and the tongue had a slight tremor; he expressed no delusions but was considered to have them; looked on his letters as nonsense, which he had written for pastime; he had never been sick, since the insane could not manage the pen. Discharged *improved* in Dec. 1878. Letters received during next six months still showed unsteadiness in handwriting. In Feb. 1879, an unnatural self-complacency was still shown in his letters. Wendt's conclusions are eminently conservative and just; "Including the three years prodromal stage, nineteen years [preceding December 1888] have now elapsed since the beginning of the disease, the remission characteristic of paralysis came on 13 years ago, and has since then continued unbroken; for 9 years Dr. F. has been in medical practice, and for 7 years he has held the office of district surgeon. Doubts may well be entertained if he has regained his *complete* integrity, but at all events an improvement has taken place that rarely occurs in *dementia paralytica*,

and which may be designated as a recovery, if the same criterion is allowed which is usual and authorized in internal diseases."

Jastrowitz appears to have coincided in Wendt's conclusions and reported a case of 17 years duration, then living and apparently well, where a diagnosis of general paralysis had been made by Westphal; a slight degree of mental weakness and apathy existed.

Müller considered Wendt's case not to be one of classical progressive general paralysis, the long course and the failure of many important symptoms usual in progressive general paralysis being opposed to it.

Zender considered it a characteristic case of general paralysis.

Mendel thought the case exceptionally interesting, and perhaps unique. The case not being *progrediens ad mortem*, they might accept Müller's criticism of the word "progressive," but they could all agree that it was a case of "cured *dementia paralytica*."

Case of General Paralysis Cured by Antisyphilitic Treatment. BYROM BRAMWELL, M. D. Studies in Clinical Medicine, 1889–90, I, p. 230. First reported in Edinb. Med. Journal, Jan. 1888, p. 630.

Dr. Bramwell's case is especially interesting in connection with the cases of alleged cure of general paralysis by surgical operation. An engineer's draughtsman, aged 32, first consulted a physician in June 1881, and was seen by Bramwell on May 1st, 1882. The history is of a typical case of general paralysis, the patient recognizing his beginning disease. The attending physician and the consultants, Drs. Bramwell and Clouston agreed in a diagnosis of general paralysis. Patient had been on specific treatment for some time, and this was continued in increasing doses. When seen six weeks later by Bramwell and Clouston, the report was as follows: "We found the patient much *in statu quo*; the vigorous antisyphilitic treatment had apparently produced very little effect; the patient had, it is true lost his delusions, but the dementia was more marked, the tremor of the lips and face, the affection of speech, and the motor weakness were quite as great, in fact apparently greater. Dr. Clouston was now definitely of the opinion, that the case was one of ordinary general paralysis of the insane, and not of cerebral syphilis—a view which he recorded some months later in his admirable clinical lectures [American Edition, 1884, p. 269]." A comatose attack preceded by rigor occurred about Aug. 1, and shortly afterwards an abscess that had formed during the attack burst, with the escape of a large quantity of pus and blood, with rupture of a blood vessel. After this, in the words of a cousin, "Mr. A. almost at once recovered his head, he continued to get better day by day until the beginning of October, when he went back to his home in Glasgow." On his return to Glasgow he was reported very much improved mentally, but still far from well. Specific treatment was continued and the head repeatedly blistered. Improvement was such that the attendant was dismissed on Dec. 18th; on Jan. 8th he returned to work; at the end of 1883 he married. On July 15, 1887, his attending physician—not the physician of 1881—stated to Bramwell that there was very little to note, as the patient has kept so well; specific treatment was being kept up; in March, 1885, the speech was so thick that the physician could scarcely understand what was said, and his manner was nervous and excited; at this time he had "fainting fits" which first came on frequently, but now (1887) only once in six weeks; fits are periodic the interval gradually lengthening; they are without warning; becomes pale, with staring eyes; if at work, becomes motionless, but does not drop his square or pencil; thinks he does not lose consciousness, but wife thinks he does; no loss of memory after a fit; speech still a little thick but quite intelligible; works regularly and is painstaking and exact; memory very good; left pupil larger than right; both contract freely, and accommo-

date; no disturbance of ocular muscles; fundus of both eyes normal. Regarding the knee-jerk the attending physician makes the somewhat anomalous statement, "the knee-jerk is normal, or rather exaggerated on the left side and nearly absent on the right, but there is not the slightest unsteadiness in his gait, nor any want of power of equilibration on making him stand with eyes shut and feet close together." When last seen by Bramwell in October, 1887, he stated that with occasional momentary "fits of abstraction," which were gradually becoming less and less frequent, he felt perfectly well. "His memory is, he says, quite good, his drawing is better than it was for years before his illness commenced; and for the past five years, he has had absolutely no symptoms of mental derangement whatever. Some physical evidences of disease still, however, remain. His speech is much thicker than it was before his illness; his knee-jerk, as tested through the trousers, seemed absent in both legs, and the attacks of *petit mal*, though steadily diminishing in frequency still continue. There is no longer any evidence of motor impairment. I did not on this occasion detect any twitchings or tremors in the tongue, lips or facial muscles; the pupils were equal and responded briskly to light and accommodation. The patient still has a somewhat heavy, stolid expression, which is probably natural to him; his memory and intelligence seemed active, and, so far as I could judge, in every way natural." After his recovery in January, 1883, he made frequent mistakes in writing, missing out letters and words, and using wrong letters and words; these mistakes became less frequent, and later were rarely observed. Up to the time of Bramwell's report, December 1889, he had continued well.

Dr. Bramwell's case is certainly of great interest, and its future history will be eagerly watched for. It is, however, somewhat odd that Bramwell should ascribe the improvement entirely to the anti-syphilitic treatment, and should not consider the possible effect of the shock following the bursting of the abscess with the loss of blood. Up to the time of this shock no improvement under treatment had been noticed, and indeed the patient was confessedly growing worse. The similarity to Dr. Claye Shaw's case (below) where improvement followed trephining immediately occurs to one. Neither does Dr. Bramwell suggest the possibility that the patient is only in a remission, but to him the case has been "cured" by anti-syphilitic treatment, although he admits that thickness of speech, attacks of *petit mal*, absent knee-jerk, and a heavy, stolid expression are still present. The history of the case at present extends over but eight years, and to the reviewer's mind it is to be regretted that Dr. Bramwell has not qualified somewhat his claims for a cure.

Surgical Treatment.

The Surgical Treatment of General Paralysis. T. Claye Shaw. British Medical Journal, 1889, II, 1090.

Is General Paralysis of the Insane a Curable Disease? George Revington, M. D. Ibid, 1889, II, 1187.

The Surgical Treatment of General Paralysis. H. Cripps. Ibid, 1889, II, 1215.

The Surgical Treatment of Intra-Cranial Fluid Pressure. J. Batty Tuke, M. D. Ibid, 1890, I, 8.

The Surgical Treatment of General Paralysis. R. P. Smith, M. D. Ibid, 1890, I, 11.

The Surgical Treatment of General Paralysis of the Insane. George Revington, M. D. Ibid, 1890, I, 749.

Considerable interest has been aroused by a discussion that has been carried on in the *British Medical Journal* over the question of the advisability of surgical interferance in General Paralysis, with the view to relieving the symptoms alleged to be due to increased fluid pressure.

To Dr. T. C. Shaw belongs the credit, if such there be, of making the first attempt to alter the course of the disease, (Dr. Shaw would claim much more), by surgical means. To his mind the pathological appearances in General Paralysis point to an irritative, probably inflammatory, process in the upper layers of the convolutions. The theory of the operation was that by producing an alteration in the existing state of the morbid process, a new and nutritive process might be set up. On the theory of nerve stretching he proposed to stretch the brain by giving it more space in which to expand, by allowing it to relieve itself of the increased arterial pressure, shown by the sphygmograph to be one of the early conditions of General Paralysis. Trephining, according to Shaw, must therefore relieve the later symptoms, due directly to fluid pressure, such as the paralyses, attacks of stupidity, and loss of power of swallowing. Dr. Ferrier agreed that the patient was rapidly approaching a condition of dementia, and that trephining offered the only hope of relief. Patient was in the second stage, with delusions of grandeur, affection of speech, exaggerated reflexes, unsteady gait and retention of urine. Convulsive attacks followed, with short periods of loss of sensation, increased difficulty in swallowing and talking, and rapidly approaching dementia. Trephined on right side of skull, over central sulcus, two inches outside longitudinal fissure. The operation resulted in such improvement that it was proposed to discharge the patient. Shaw states that he did not expect any improvement in the bulbar symptoms, although even here his condition was thought to be better, as he swallowed and spoke more easily; he became less optimistic, and the epileptoid attacks ceased. Shaw considers that the operation was justified by success, although the prominent bulbar symptoms remained.

Mr. Cripps, who performed the operation, speaks less positively of the pathology of the disease. Of the post-mortem conditions, diminution of brain substance and increase of fluid, there is to his mind no absolute evidence to show whether the brain atrophies from pressure of the fluid, or whether the fluid collects on account of the shrinking of the brain. The operation was performed on the former hypothesis, and the extreme manner in which the dura bulged into the wound from the tension of the fluid beneath is considered by the operator to show that the former hypothesis was the correct one. By removing a portion of the bone, with the corresponding meninges of the brain, not only would the existing fluid be let out, by opening the water-proof brain coverings, but a permanent contact would be established between the secreted fluid and the under surface of the scalp-flap, to the absorbents of which was entrusted its future removal.

On these surgical procedures, from theoretical considerations, very obvious and just criticisms are made by Revington. To justify a new and serious surgical operation three conditions should be observed: (1) The theory of the pathological process to be remedied should be unassailable; (2) the mechanical means adopted should be clearly competent to produce the result; (3) the resulting improvement should be the indubitable consequence of the procedure adopted. These conditions have not been even partially satisfied. It is extremely doubtful that the "paralyses, attacks of stupidity, loss of power of talking and swallowing," are due to fluid pressure, but the probabilities are all the other way, that the excess of fluid is a secondary and compensatory process. Further, it is not easy to see how pressure due to fluid in the convolutions could be relieved by a hole in the skull. Finally, the symptoms which Shaw regards as cured by the operation are symptoms which frequently disappear of their own accord. It is extremely probable, therefore, that the favorable symptoms were in no way the result of the treatment except in so far as an issue in the neck might have operated favorably. To Revington, curing General Paralysis, "with no

marked improvement in the bulbar symptoms," is like curing paraplegia without restoring the power of walking, and the permanence of the bulbar symptoms is a curious commentary on the assertion that the loss of power of swallowing, talking, etc., are directly due to fluid pressure.

Dr. Batty Tuke's case appears to have been further advanced than Shaw's. Patient was trephined a little above and in front of the parietal eminence on both sides. No sign of bulging of the brain into the hole was observed; the buttons of bone were not returned. In the first case it was held that the bulging of the brain into the trephine hole upheld the pressure theory; the second operation was performed on the same theory, but the absence of bulging in this case is not cited as in any way militating against the theory. It was thought that for five days after the second operation the pupils reacted better to light, and the intellect of the patient was distinctly clearer, and "he was evidently more sane than previously." After five days the old symptoms returned. He was removed to Morningside, and Dr. Clouston thought the operation might possibly have modified the symptoms. When last seen by Tuke, the patient was much demented, with well marked ataxia, and showed progressive symptoms of a downward tendency. Tuke felt that the results justified the operation.

Dr. Smith's paper is a criticism of Dr. Shaw's case; he deprecates that it should not have been made to appear that it is no new thing for general paralytics to so far improve that they have to be discharged "recovered," because there are not sufficient symptoms to warrant their legal detention, though the physician may be convinced that they will eventually relapse and end fatally,.and he quotes several such cases.

He does not admit that the operation was justified by success, and doubts whether the trephining had any more to do with the improvement than any other injury might have done. Smith quotes Mickle, where in several instances "recovery," or very long periods of remission have supervened on accidents, violent injuries, or diseases of such a kind as to produce revulsive effects.

Revington's criticisms in Tuke's case appear to have ended the controversy, for a time at least. Tuke's description of the case, according to Revington, shows that the disease made rapid progress, and the patient seems to be worse off than many a ten-month paralytic with a sound skull, so it is not at all sure that the operation may not have "modified symptoms" in a way not anticipated by its originators, and he must be a sanguine man who would take the improvement noticed during five days after the operation as worth much. It is, however, on the ground of the false pathological theory that the two operations are chiefly to be criticised. The pressure-theory, according to Tuke, makes it certain that obstructed lymph can make its way but imperfectly by natural channels to the pia-matral space, and becomes diffused through the tissues, injuring and displacing cell and fibre, and impairing their functional activity, while the operation, by permitting a healthy action of the lymphatics and blood vessels, stays the process of sclerosis. Revington is probably right in saying that the entire mass of pathological evidence is absolutely contradictory of such a theory as this, and that the typical cell degenerations found in General Paralysis are not such as may be expected to follow simple excess of fluid pressure, but is rather (citing Bevan Lewis) a true degeneration, due to acute interstitial anomalies, with no notable differences between the changes through which the cells pass and those in senile atrophy, and that there is no excess of fluid in the first stage, while the second stage is one of extraordinary development of the lymph connective system of the brain, with a parallel degeneration and disappearance of nerve elements, the axis cylinders of which are denuded. In the first stage, then, the only stage

in which an operation would be justifiable, there is no excess of fluid, and in no stage is the excess of fluid of more than secondary importance. We may, therefore, conclude with Revington that the results in Dr. Tuke's operation are quite insignificant; that the results of Dr. Shaw's operation are most probably due to a remission; that the pathology upon which the operations were founded is opposed to all the best knowledge on the subject, and that the collation of two cases warrants nothing so clearly as the opinion that little good can be expected from the operation of trephining in General Paralysis.

III.—EXPERIMENTAL.

Ueber das Erkennen der Schallrichtung. J. VON KRIES. Zeitschrift für Psychologie. Bd. I (1890), H. 4—5, S. 235.

The ear perceives the direction and to some extent the distance from which sounds reach it; is this a judgment based upon the difference of the primary sensations reaching the two ears, or is it the more or less simple sensation of a special organ? The results of a very few rough trials will convince any one that right and left location is much more exact than location in any direction in the median plane; and this fits very well with the theory that sound is located by the difference of intensity of sensation in the two ears, because in the last case the two ears are always equally stimulated. Such recognition of direction in the median plane as is actually found has then to be explained by changes in the quality or intensity of the sound as its point of production is shifted about the head in that plane. Even this ought to fail, however, in the case of sounds with the quality and intensity of which the experimentee is unfamiliar, and this is the point which v. Kries set himself to try. The sounds of a telephone, of whistles, of bits of wood or metal snapped together — all of them variable to a certain degree in quality and intensity at will — were produced at different points in the median plane. The experimentee had to decide between but two possible locations (*e. g.* before or behind); he was kept in ignorance of the correctness of his answers, and in general every precaution was taken to prevent his learning the character of the sounds so as to be able to judge by that of their positions — as also to prevent a betrayal in any other way of their location. The experiments were made largely upon v. Kries and his assistant, but in addition some 22 students were also tested. In the first experiments (comparing forward-and-upward with backward-and-upward, telephone click as stimulus) the location was very uncertain; the next set (forward-and-upward as compared with forward-and-downward, whistle stimulus) gave much better results, as did also the next (upward compared with backward, stimulus by snapping coin). In other experiments where a continuous noise was produced by the telephone for 0.5—1 sec., the location was still more exact; *e. g.*, v. Kries, with before and behind as directions, made 39 correct judgments out of 44 trials, 4 times was in doubt, and only once answered incorrectly. On the 22 students very few trials were made, only five or six on each (comparing backward with forward) so as to exclude still further the possibility of learning the sounds. On the whole, the results of these experiments did not show exactness of location, a fact not much to be wondered at, perhaps, in so few experiments, but did show very great individual differences in this power. One student answered the first six times correctly, in an additional 30 trials was right 29 times, and showed an almost equally exceptional power in recognizing other directions.

For the detail of the experiments, as for points of incidental interest, the reader is referred to the original. Among others, however, may be mentioned the following: The occurrence of constant tendencies to say

one particular direction, however the actual direction might be changed; the experiments on ability to recognize the distance of a sound, which seemed to show that it did not depend to any great extent on the loudness; also those on the simultaneous recognition of the direction of two sounds or a sound and a noise; the author's criticism of the Lotze theory of local signs for vision and the similar theory of Münsterberg for auditory localization. Von Kries concludes somewhat as follows. Two things appear from these experiments, in spite of their relatively small number: First, an approximately certain median location is possible under some circumstances (at least in case of discriminating before and behind), even when the sounds used change irregularly from experiment to experiment in intensity, quality, and distance; second, that under other circumstances the location is remarkably uncertain. [To the reviewer it seems regrettable that von Kries did not experiment with the experimentee's head fixed, (he was only instructed to keep it still); for certainly in the case of sounds which last an appreciable length of time a very slight, and possibly unconscious, motion of the head might be expected to be an immense aid in deciding between before and behind.] E. C. S.

Zur interaurealen Lokalisation diotischer Wahrnehmungen. KARL L. SCHAEFER. Zeitschrift für Psychologie, Bd. I (1890), H. 4—5, S. 300.

Equal intensity of sound in the two ears regularly gives median location, but intercranial location only under certain circumstances. Sylvanus Thompson observed that when a telephone is held against each ear a single intercranially located sound is heard, provided that the diaphragms of the two telephones vibrate at the same rate, with the same amplitude and in contrary directions, *i. e.* both at the same time toward the head or both away from it. When the last condition is not fulfilled the sound is double and located in both ears. The explanation of this is briefly as follows: Sounds are located on the side on which they are most intensely heard; if the intensity alternates slowly, they seem to shift from ear to ear; if the shifting is very rapid they may appear to be located in both ears; such an alternation of intensity and quality is given by the telephone diaphragms on their inward and outward swings. Intercranial location, as opposed to extracranial, seems to depend on the estimated nearness of the individual sounds (a stimulus to a single ear never produces it), and this in turn seems influenced by intensity. If the single sounds are located away from the ears, the location of the combined sound is extracranial; if in the ears, intercranial. For the simple and interesting experiments which support these conclusions the original should be consulted.

Urtheilstäuschungen nach Beseitigung einseitiger Harthörigkeit. W. VON BEZOLD. Zeitschrift für Psychologie. Bd. I, 1890, H. 6, S. 486-487.

Von Bezold relates the following interesting experience of his student days. At that time he suffered for a considerable time from extreme deafness in the left ear, which later proved to be due to a wad of cotton which had been driven in against the ear-drum and there become fixed. When this was removed, the resulting illusions were of striking intensity. Turning the leaves of a book under such circumstances "produces a noise that can only be compared to that of a powerful waterfall, and would rise to pain, if the sensation were not diminished by stopping the ear with cotton." Still more important were the illusions of localization due to the disproportionate sensitiveness of the left ear. Sounds were localized always too far to the left, and sometimes, even when they came from the right, were referred to that side. This illusion was so disturbing as to give considerable discomfort in crossing

streets and open places. It was three weeks before the true localization of things was tolerably re-learned, and six before errors disappeared.

Eine Methode zur Beobachtung des Simultancontrastes. E. HERING. Pflüger's Archiv, Bd. XLVII, H. 4—5, 1890.

In this paper Hering describes a new method of performing his characteristic experiment for demonstrating the physiological nature of simultaneous contrast. Two sheets of even-surfaced colored paper, say blue and yellow, of complementary color-tone, are laid close together with their line of junction perpendicular to the median plane of the head. Two narrow strips of the same papers are laid at right-angles to the line of junction, but not reaching quite to it, one above the other, the blue on the yellow and the yellow on the blue. The whole is now looked at through an acromatic double refracting prism in such a way as to double the images of the strips, but not the line of junction. Each of these double images physically represents a mixture of the complimentary colors of the strip and the ground, and might be expected to look gray. As a matter of fact however, each is seen distinctly in its own color, in other words, the color complementary to the general field in which it lies. The effect is said to be very striking. In this form the experiment is not free of successive contrast, but is easily made so by furnishing the eye with a fixation point and keeping the colored fields covered till the instant when the observation is to be made. White paper may also be introduced about the color fields and the phenomenon thus be demonstrated not to be due to a changed notion of what white really is. Helmholtz has regarded it as important that the strips should seem to be a part of the general colored field in which they lie, but the modifications of this experiment, especially the binocular form of it, show that to be quite unessential. These experiments and others like them which Hering has devised should leave the "psychological" explanation of simultaneous contrast without a supporter. An instrument designed by Hering for these experiments is made by R. Rothe, Universitäts Mechaniker, deutsch. physiol. Institut, Prag.

Zur Theorie des Farbensinnes bei indirektem Sehen. A. FICK. Archiv f. d. ges. Physiol., Bd. XLVII (1890), H. 6-7-8, S. 274-285.

The points urged by Hering in the critique to which Fick here replies (see review, AMER. JOUR. PSYCHOL. III, 204), were partly dialectic and partly experimental. The first Fick seems to have little difficulty in turning, and in the second he even finds support for his own position. That a certain red and green (or rather blue-green) on moving toward the retinal periphery should lose in saturation and finally become white without changing in color-tone (Hering's central fact), he shows to be not only explained, but required by his own theory.

Ueber die Tonänderungen der Spectralfarben durch Ermüdung der Netzhaut mit homogenem Lichte. Dr. CARL HESS. Archiv für Ophthalmologie. Bd. XXXVI, 1890, H. 1, S. 1-32.

In this study, as in that upon the color sensations of the peripheral portions of the retina (Review, AMER. JOUR. PSYCH., Vol. III, p. 208), Hess subjects a set of facts, already long known, to a careful re-investigation, and brings from his more accurate results consequences of importance. When the eye has been fatigued by gazing some seconds at one color, other colors upon which it is turned do not appear as to the unfatigued eye, but are changed in a certain fixed and definite manner. What these changes are when the colors are homogeneous spectral lights (and purples mixed from spectral red and violet), and when the other conditions of the experiment are accurately fixed, was Hess's problem. The apparatus used was designed by Hering in whose

laboratory the work was mostly done. The detailed statement of results can of course not be summarized, but the general nature of them can be seen in the results of a series of experiments in which the changed color was directly compared with that produced by spectral light on another unfatigued portion of the retina. 1. After fatigue from Red (between line C and the red end of the spectrum) Violet (between G and H) appeared Bluish-green, of tone about like wave-length 478 $\mu\mu$. 2. After fatigue from this Violet, spectral Red appeared Reddish-yellow of tone about line D (wave-length 589.7 $\mu\mu$), or even beyond. 3. After fatigue from Red, Green (between E and b) appeared a Greenish-blue (489–488 $\mu\mu$). 4. After fatigue from the same Green, Red appeared Bluish-red. 5. After fatigue from Blue, (wave-length 442 $\mu\mu$), spectral Red appeared like a Reddish-yellow, of less than 600 $\mu\mu$ wave-length.

Now it is possible by taking the color triangles and curves for the sensations produced by spectral lights which Fick and others (most recently König) have drawn, to predict, according to the Young-Helmholtz theory, at least for fatigue from certain colors, both the direction and the extreme limits of change to be observed in other colors. This Hess does for the typical curves of König and Fick, finding the predictions not verified by the facts. In König's curve, for example, fatigue from Yellow (wave-length 575 $\mu\mu$), which depends on the equal stimulation of the red and green fibres, should have little effect on the appearance of the colors at the red end of the spectrum in which the blue fibres are not active. The actual effect, is however, that these colors become more or less bluish. Fatigue from Red should make Violet appear a little bluish, and complete fatigue, (enough to cause temporary red-blindness) should make it only blue. As a matter of fact a fatigue of 30 seconds makes Violet appear Greenish-blue.

If, however, as Helmholtz and Fick assume, *all three kinds of fibres* are active in case of *every* color, though in differing degree, discrepancies are not avoided. Fatigue from Green should cause equal fatigue for the red and blue fibres, thus no change in their proportions; from which it follows that Violet should undergo no change in tone. Experiment shows it to become redder. The extremest fatigue for Blue should change Red but little toward Yellow (a little beyond line C). As a matter of fact it changes it nearly to line D.

These examples are sufficient to show the difficulties which these experiments offer to the supporters of the three-color theory; to the four-color theory of Hering they apparently offer no difficulties.

Zur Diagnostik der Farbenblindheit. E. HERING. Archiv für Ophthalmologie. Bd. XXXVI, H. 1, S. 217-233.

After discussing a number of the commoner methods of testing for color-blindness, and showing that, while they answer well enough for determining deficiency, they are not suited to reveal complete defect, Hering lays down as conditions to be fulfilled the following: The colors with which the test is made must be of the fullest saturation; the areas of color must be of sufficient size; they must be without spots or roughness; they must be immediately adjacent to each other in an otherwise even and colorless field. With ordinary apparatus these conditions are difficult to satisfy or make the testing a very lengthy process. In *Pflüger's Archiv*, Bd. XLII, S. 119, Hering has described an arrangement of the dark room which serves well, and now he explains and illustrates by a couple of cuts a portable and rapid instrument for the same ends. In outline the scheme of the instrument is to place in the field of view of a vertical tube, two inclined mirrors, each occupying one-half, and each reflecting colored light, one green, the other red; the first adjustable in saturation, the second in saturation and color tone.

By these means an exact matching of colors (as they appear to the color-blind eye) can be made, either between red and green, or between red or green and gray. Besides showing the presence of complete red-green blindness, it also distinguishes the "red-blind" from the "green-blind" forms of red-green blindness, in Hering's words, the "*relativ blausichtiger Rothgrünblinder*" from the "*relativ Gelbsichtiger.*" It also seems capable of adaptation to other types of visual disturbance, some description of its application to which the author may publish on another occasion.

Die Untersuchung einseitiger Störungen des Farbensinnes mittels binocularer Farbengleichungen. E. HERING. Archiv für Ophthalmologie, Bd. XXXVI, (1890), H. 3, S. 1–23.

Of great interest for the theory of color vision are those cases in which color-blindness is confined to a single eye. In order, however, to yield the most exact and valuable results, the patient must not be asked to describe the colors of things seen, for this he often does inaccurately, but to match the colors seen with his color-blind eye alone with those seen at the same time with his normal eye alone. This is possible if an area of color is so presented to each eye that the one seen by the right eye is wholly invisible to the left eye, and *vice versa*, and if the two areas lie upon disparate retinal points, (*e. g.*, on the temporal halves of the eyes), and thus escape binocular combination. Under such circumstances, very delicate comparison of colors is possible. Under the title given above, Hering describes (with one illustration) an instrument for testing such cases, and reports the result of an application of it in the case of a woman whose vision on the right side was reduced by atrophy of the optic nerve to about one-half the normal acuteness, with marked disturbance of vision for colors. The tests showed that all colors appeared more whitish or grayish to the color-blind than to the normal eye; yellow and blue did not suffer any noticeable change in their color-tone; unsaturated primary red and green (Hering's *Urroth* and *Urgrün*) appeared colorless; the intermediate colors tried, (red of spectral tone, orange, yellow-green, and unsaturated violet), lost their red or green character entirely, and appeared whitish or grayish yellow or blue; white, gray and black were for both eyes the same. The red-green vision of the patient was, therefore, nearly destroyed, the blue-yellow vision much weakened. Other tests with spectral colors gave concurrent results. Tests of the acuteness of the patient's peripheral color-vision showed the color fields reduced in size; and careful tests of the same (made later) with the color-mixer, showed that the limits of the field for the members of each color pair were the same; red and green 5°, blue and yellow 30°. Still other tests showed that colors which matched for the sound eye, also matched (*i. e.*, both suffered equal change) for the defective eye. It is hardly necessary to say that these facts speak strongly for Hering's four-color theory and against the three-color theory of Helmholtz.

Untersuchung eines Falles von halbseitiger Farbensinnsstörung am linken Auge. C. HESS. Archiv für Ophthalmologie, Bd. XXXVI, (1890), H. 3, S. 24–36.

In the case of monocular color-blindness examined by Hess, the defect was still more limited than in Hering's case, occupying, indeed, only the nasal half of one retina. The patient was a man of about thirty years and near-sighted. The sharpness of vision in the affected eye (both supplied with proper glasses) was about one-half that of the other. The colors to be matched were this time presented, one to the nasal, the other to the temporal half of the single eye. Tests with pigment colors, homogeneous spectral lights and the perimeter gave results not essentially

different from those of Hering. In this case, however, the disturbance was apparently more serious, for the red and green of the perimetical tests could not be seen on any part of the diseased half-retina, and the sensitiveness to white light was a little less than normal. The case, of course, justifies the same conclusions as Hering's above. In both cases a condition of things has been brought about on the central parts of the retina by disease, which exactly corresponds with that on the more peripheral parts of the normal eye.

The Knee-jerk and its Physiological Modifications. By Prof. H. P. BOWDITCH and Dr. J. W. WARREN. Journal of Physiology, XI, 1890, 25–64.

It has been known for some time that muscular contractions and various sensory and other conditions affecting the central nervous system could considerably re-inforce the knee-jerk, also that the re-inforcing contraction must precede the stroke upon the tendon by a certain interval. To the study of this point the experiments of the present paper were directed. The apparatus was somewhat complicated, but is marked by the clever devices common to Dr. Bowditch's laboratory, and is fully described. The general results may be summarized somewhat as follows: A voluntary muscular contraction (in response, after the manner of reaction-times, to a bell-stroke) increases the knee-jerk, if the blow on the ligament falls at the time of the contraction, and in lessening degree if it follow within 0.22–0.6 sec. A larger interval than this resulted in eight cases in a decrease of the knee-jerk below its normal amount, to which, however, it returned as the interval was extended to 1.7–2.5 secs. In 2 cases there was no such negative phase. In the majority of cases, therefore, contraction of the arm muscles produces for a short time a state of increased excitability in the part of the spinal cord that mediates the knee-jerk, followed in turn by a short period of decreased excitability. Sensory re-inforcements were investigated, by the explosion of torpedoes, the flashing of light into the eyes, a blast of air on the conjunctiva, on the nasal mucous membrane, on the neck, and on the knee. These experiments were tried on fewer subjects than the motor re-inforcements (3 or less) and the individual differences are marked. With a portion of the subjects there is a positive phase but hardly any negative, while in one both phases are plainly marked. The experiments were monotonous and in some the subject fell asleep. Oncoming drowsiness decreases the extent of both normal and re-inforced knee-jerks, and sound sleep abolishes them, an effect the opposite of that produced by the same conditions upon the superficial reflexes. The authors make the interesting suggestion that the individual variations in the activities of the central nervous system which their experiments show may open the way to an understanding of those general psycho-physic modes of response vaguely known as temperaments.

Zur Messung der Reactionszeit. OTTO DUMREICHER. Inaug. Diss., Strassburg, 1889.

Twenty-one pages of this dissertation are devoted to a historical resumé of "personal equation" and reaction-time studies, in particular of those among the latter where the stimulus used was electrical and applied to the skin. Another considerable section is devoted to the description of the apparatus used, which included several ingenious devices of Ewald's — among the rest a new chronoscope, and a reaction key which is so arranged that the stimulus can be applied to the tip of the finger with which the reaction is made. The chronoscope, which is a very promising instrument, consists essentially of an electro-magnet, the armature of which works upon a toothed wheel connected with a pointer moving over a dial. If, now, a tuning-fork interrupter is intro-

duced into the circuit with the magnet, each vibration of the tuning-fork causes an advance of the pointer one degree on the dial. The observer switches the fork into the circuit as the stimulus is applied, the subject switches it out when he feels the stimulus, and the time consumed is read off in the number of tuning-fork vibrations shown by the dial; *e. g.*, in hundredths of a second, if a tuning-fork making 100 vibrations a second is used, as in Dumreicher's experiments.

The aim of the experiments was the development of a method that should be simple enough, and at the same time give regular enough results, to make reaction-time tests readily useful in the clinique and laboratory. The recommendations are as follows: 1, Use a strong electric stimulus at the end of the finger with which the reaction is executed; 2, react by withdrawing the finger; 3, use for the warning signal a sound of short duration given 2 or 3 seconds before the stimulus; 4, take the single reactions in sets of 10, at 10-second intervals, with several minutes' rest between the sets; 5, in training the subject always tell him at the time the amount of each reaction; 6, in drawing the mean disregard the first 3 or 4 (always the same number) of the series. The reactions by withdrawing the finger are not only more regular but shorter by 0.03—0.04 sec. than those by pressing the key, probably because more nearly like the natural reflex retractions.

The Time-relations of Mental Phenomena. JOSEPH JASTROW. Fact and Theory Papers, No. VI, published by N. D. C. Hodges, N. Y., 1890, p. 60.

Those that are familiar with Prof. Jastrow's unusual skill in presenting the results of psychological experimentation in concise and intelligible form, need not be told that this little monograph is excellent in both respects. We have no hesitation in saying that it is the best general account of the subject extant, both as regards the maintenance of proper perspective and as regards the extent and freshness of the material gathered. The book provides for those that wish to consult original sources by a classified bibliography of some fifty-seven titles. It should be useful to all those that contemplate psychology from the experimental or clinical side.

IV.—MISCELLANEOUS.

The Principles of Psychology. By WILLIAM JAMES, Professor of Psychology in Harvard University. Henry Holt & Co., 1890. Two volumes, pp. 689 and 704.

This long promised, long delayed book appeared in October last. Its size and the volume of matter it contains as well as its rare vigor and acumen makes the task of the conscientious reviewer hard.

Important as are our differences *in re*, and abrupt and summary as space limits compel us to seem *in modo* let no reader forget that gratitude and admiration are predominant. Our indebtedness for stimulus and self definition to both the man and his book are very great.

The book opens with an excellent chapter on the functions of the brain[1] which is a good illustration of the way in which such subjects as speech disorders, reaction-times, the psychology of vision, the phenomena of suggestion and trance, the psycho-physic law, etc., should have been handled, instead of being broken up and treated, parts here, parts there, torn from their natural and usual connections to be brought to bear upon the speculative controversies in which the author's interest centres. Habit is then treated in a general yet chiefly hortatory way. We are told to do something every day because we do not wish to do it to keep the faculty of *effort* (one of the supremest things in this treatise) alive. We must begin early and hand over all we can to our automaton. In treating the automaton it is urged that the mind is not an epiphenomenon. If feelings cannot

[1] See page 551 in this number of the JOURNAL.

cause nerve action they cannot cause each other, but however inwardly rational they can only be juxtaposed, the brain's "hair trigger organization makes it a happy go lucky, hit or miss affair." "It is as likely to do the crazy as the sane thing." Consciousness is "an organ added for the sake of steering a nervous system grown too complex to regulate itself." Consciousness has causal agency and loads the dice or tips molecules, and this is why it is most intense where nerve processes are most hesitant.

Although metaphysics, which "spoils two good things when she injects herself into natural science," (preface, vi) is expressly and often excluded, chapter VI, is announced as "exclusively metaphysical." Fick's heat summations, tone sensations due to individual vibrations, Spencer's theoretical primordial nervous shock, etc., are all physical integrations below the threshold of consciousness. Even lemon and sugar are not present in the taste of lemonade, but an entirely new taste. If elemental psychic units existed they could never associate or communicate. The Helmholtz-Wundt conception of unconscious inferences, somnambulism, Leibnitz *minimum visibile et audibile*, all notions of nascence or continuity between brain and mind states, material monadism or polyzoism with one arch pontifical cell, etc., are all denounced more than refuted, as either "one tissue of confusions," or "pure mythology" on which comment "seems hardly called for," a "tumbling ground of whimsies," a "bog of logical liquefactions," illustrating the "silliness of the mind-stuffists, or a temper with which the authors cannot contend and best left to its devices," "where Spencer fairly outdoes himself in vagueness" or "well illustrate the scandalous vagueness with which this sort of chromo-philosophy is carried on," or are "unintelligible and fantastical," and "it is hard to believe that intelligent men could be guilty of so patent a fallacy." Such phrases are applied not to, *e. g.* Mr. Cockayne's Leechdom, Wort-cunning and Star-craft, a strange collection of old wives' cures, but to the views now inclined to by many if not most of the best men of science, and do not suggest the philosophic temper or poise. Split-off consciousness, instant and total forgetfulness may explain much, but when we are told that psychic elements can never really combine, that atoms of feeling cannot compose higher feelings any more than atoms of matter compose physical things, that the entire brain process is not a physical fact at all, I. 178, we simply re-read but do not fully understand how the author knows.

In *the stream of thought*, Ch. IX, where the mind is first studied from within, Dr. James warms to his subject and is perhaps at his best. This is in some sense the key-chapter to all the rest. *It thinks* is the first and simplest fact for psychology. These series of unorganized impersonal thoughts are seen in trance, disaggregated and unowned, but always tend to be parts of a personal consciousness. Whether we personify the procession of thoughts, or that procession is the self, each train of them is isolated by one of "the most absolute breaches in nature" from all other selves. The thoughts in the stream are in ceaseless Heracleitic flux, and the same thought or sensation is never repeated [Hodgson]. The objects only are the same but no two psychic impressions of or brain states caused by them are the same. The successive ideas of the same thing have no identity. Their instant *esse* is *sentire*. They are as they are felt. Dimness and clearness do not pertain to states of mind but only to the objects they stand for. The minimal psychic fact which is closest to any brain state is the entire thought, for mental chemistry and psychic synthesis are denied. Contrast is invoked, and it is even said that a telephone plate thrills for years yet never reduplicates its inward state to prove the exiguous point that the notion of identical ideas or impressions which re-appear is a myth. Despite time-gaps the

thought procession connected with each self is a continuum. The train is not chopped up but inwardly connected as parts of a common whole called *I* or me. Even in the greatest contrast the joint or link between the two contrasted members is a part of consciousness. The stream is "made of an alternation of flights and perchings." The perches represent sensory, images objects, and as substantive are contrasted with the transitive flights. (This happy form of statement should have been credited to Wundt.) The flights are very hard for introspection to catch or name while the perches are easy so that a sensationalism which denies feelings of relation as Hume did is easier than to ascribe it to an *actus purus* of reason. Vocal inflections, adverbs, prepositions, conjuctions, interjections, various signs of direction and grammatical tendencies abundantly prove these dumb relation-feelings. Words have both static and dynamic fringes or overtones of relationships, and these may be the same for verbal, or visual imagery [Galton]. Thought is an algebra of relations, [Berkeley], and while the assigning of values to the symbols is like the perches of thought, it is the fringes and transitive elements that make it a continuity. The reason why we come to think that our thoughts have "extra mental duplicates" or objects corresponding to them is that thoughts of many selves have the same objects. If *my* thought has the same object as *his* we believe it objective and real. Hence the great importance attached to *sameness*. In swoon there is a sense of being, or objectivity is general without any sense of self, which latter is added on awaking. Hence the sense of the object is first, and knowledge that we know it or the consciousness of self is not primordial, so that all who like Green say that to know and to know that we know are identical are wrong, and thought may or may not discriminate between the object and itself. The object is not the nucleus of a state of consciousness but all that the thought thinks just as it is thought, hence introspection can only gather up a few of the crumbs later. Again there is no Kantian *manifold* but all that is thought is in a single unitary pulse. The idea of a pack of cards is not a pack of thoughts and our notion of a large number or an army is one feeling. In the simplest sentence the states, tensions, halos, fringes, change with every word. The words are consubstantial with the idea and not over against it as Egger holds. Again some objects in the stream are emphasized and selected by attention. Our very senses are organs of selection ignoring some wave lengths and many subjective phenomena, and making what we call things out of the chaos of sensation. Reasoning, æsthetic activities, and supreme ethical choices are other forms of selective action which altogether have given us our physical, mental and moral world by filtering it out of the primordial sea of sensations and atoms, and dichotomizing and setting it over against each of the many selves whether of worm or man as its world: All this because we cannot disperse attention evenly over all objects but must inhibit, ignore, eliminate, unite series of uniform strokes to rhythm, and make and then break up totalities, etc.

We now see the author's idealism. It is the phenominalism of Hodgson and Renouvier emphasized till the very states of consciousness seem so real as to have causal force, or the realism of Herbart with his physics and mathematics and indeed all exactness taken out. Waving this, he is too eager to use abnormal experiences as yet only tentatively explained to help out both the theory of impersonal thoughts, pp. 226-9, and of object-knowledge as primordial p. 273. In recent physiological grammars the forms and acts of the "sentence sense" are explained in a simpler, more complete and exact way than by these "fringes," "relation feelings," transitive and other processes. For Hartmann these are among the strongest proofs and types of his "unconscious." Who can decide; and why force this irrelevant issue? Nor can we harmonize

the contentions for the consubstantiality of idea and word with the distinction drawn between mind states and objects, or with any theory of sameness. There is no possible test to decide between Egger and James and why force facts to fit with theory? That contrast is a "joint" is good Hegelism.

Ch. X. The description of the social, spiritual and pure self, of rivalry, self-seeking and feeling are delightful and picturesque. The nuclear self of minimal primary tensions and reactions (which are very different from Wundt's apperceptions with which they seem to be identified) does not preclude a back-ground self which may become its own object. The central self of selves, the shepherd or "herder" of the thoughts, etc., is not needed to explain the facts of consciousness. Better an *anima mundi*. The self is the passing thought, differing each moment but appropriating the thought of the past moment and all it had. The thought is itself the thinker. The author declares himself "persuaded by abundant acquaintance with the trances of one medium that the 'control' may be altogether different from any possible waking self of the person. In the case I have in mind it professes to be a certain departed French doctor, and is I am convinced acquainted with facts about the circumstances, and the living and dead relatives and acquaintances of numberless sitters whom the medium never met before and of whom she has never heard the names." [I, 396.] Various facts in the Lurancy case "increased the plausibility of the spiritualistic interpretation of the phenomenon."

In this chapter the author fails to utilize the great ethical opportunities he makes so much of in treating habit. Poor Kant's "cheap and nasty editions of the soul," concerning which his "unintelligibilities became quite paroxysmal," is called "as ineffectual and windy an abortion as philosophy can show."

Chapter XI. Brain cells may be excited from within by other brain cells or perhaps by spiritual process. Attention is the nucleus of our inner life, and volition is "nothing but attention." The central question in this chapter is the "metaphysical as well as psychological one whether attention involves a principle of spiritual activity. This is pivotal, the very hinge on which our picture of the world shall swing from materialism, fatalism, monism, towards spiritualism, freedom, pluralism, or else the other way." The cause theory is held to as opposed to the effect theory. The feelings probably result dynamically upon the cell activity. Attention is an original force. He "counts himself among the believers in a spiritual force," and those who do not are "intensely reckless" and are charged with strange arrogance.

The chapters on Discrimination and Comparison, and on Conceptions need not delay us. The latter are unchangeable and nothing can be conceived of twice alike. No concept can ever change into another but remains eternally what it is. An idea neither is what it knows or knows what it is. Difference is a sensation. When we say A differs from B, we do not compare two distinct ideas but the different-sameness is one unique pulse of thought, I, 500 *et seq.* Each thought is a continuum, a plenum, needing no contributions from another. Fechner's psycho-physic law,—explained only in the most generic and summary way—is "amusing," a "patient whimsy," "dreadful literature," and its outcome is just "nothing," etc. The pregnant and far-reaching idea of the *threshold* (as irreconcilable as are "fringes" and transition states with the basal position of the "mind-stuff" chapter), the exact and patient experimentation which lifted a whole section of psychology to the plane of science by enabling it to re-identify psychic states (no two of which can be identified according to Dr. James) combine to make this field the most critical of all for his basal assumption, as its methods are most contrasted in thoroughness and exactness with his. Old

Caspar's house was on the battlefield of Blenheim as Dr. James' system is in the field of this discussion. But we should expect the latter's explanation to be more intelligent than Caspar's, because the psychophysic battle is still undecided, but it is scarcely more so.

Association is not of ideas but only of objects thought of. It is of course all on the plane of consciousness for all psychic synthesis out of ulterior simple elements was denied in Chap. VI. Here neural action is chiefly invoked, yet "possibly these will not suffice and we shall need to invoke a dynamic re-action of the form of consciousness upon its content." Even in voluntary association the order of presentation of mental material is "due to cerebral physiology alone." Contiguity and similarity of ideas can only exist after the association is done. Similarity does not exist till both things are there, so it cannot be an agent in producing anything. The object may bear any relation whatever to that which suggests it. Herbart is "repulsive, almost hideous," because each idea is regarded as an entity out of consciousness and their struggle and inhibition are too mechanically conceived. In a word the brain produces all sorts of ideas in all sorts of directions and consciousness afterwards classifies the links as best it can.

We have a unique feeling of pastness, Ch. XV, to which every feeling in turn falls a prey. This is a simple feeling or state as is the feeling of difference or of space, but of another quality. To successive feelings, a feeling of their own succession must be added and treated as another fact. The "specious present" is the few seconds that can be steadily intuited at once. This immediately-known time is the type and measure of all conceived times. An "over-lapping of brain processes" said to be related to after-images and to serve in some sense as a temporal sign is invoked to explain the feeling of duration. So primary memory, Ch. XVI, is of the nature of an after-image or after-consciousness. Secondary memory has an additional consciousness of previousness added to knowledge. There is no revival of an image, but there is a "second event, having absolutely no connection with the first save that it happens to resemble it." The tick of the oldest clock does not become aware of past ticks because these are physical and not psychic objects. It must be referred to the past and to *my* past to be memory. Both retention and recall are caused by the habit of the nervous system working by association, but even the brain states excited by an event and by its recall differ.

After inner comes outer perception and first sensations. The latter are marked by "extreme simplicity" and their natural history and classification is entirely omitted. There are no pure sensations at least after the first day of life. The infant's first sensation is the universe. The knower greets the world in the miracle of knowledge. Contrast, which shows that sensations are not immutable psychic things, is physiological as Hering says and not psychological as Helmholtz thinks. Sensations do not appear first as internal and get afterwards projected outward, but only get translated and "shoved further off." From the first they have a roomy and spatial character and that independent of other sensations. The assumption that because bodily processes cause, they must also seem to be the seat of sensation is false. Subjectivity is one of the latest notions to be acquired. Copies of sensation may re-arise—the neural processes which underly imagination, starting in the brain, may excite sense organs. So imagination differs from sensation only in intensity and not in its locality. Vague images are not general notions. "Perceptions are not inversely as sensations and differ from them by the consciousness of further facts associated with the objects of the sensation." The escort of revived sensations are integrated. Not sense but intellect accounts for most fallacies of sense. Most of what we perceive comes not from the object

but from our own head. Hallucination may probably be centrally initiated. Perception is not an unconscious inference but a brain product, and both it and hallucination are elaborately explained as such. Apperception is but little more than mentioned.

The perception of space starts from a feeling of "crude extensity," involving the third as well as other dimensions. All our sensations are inexplicably extensive but do not all contribute to space perception. The hypothetical feelings arising from joints play the chief rôle in the development and discrimination of space perceptions and the muscle-feelings play no appreciable part in it. Discriminative attention subdivides the total dermal or retinal bigness by the aid of movements. The different space senses are at first incoherent and must be compared, reduced to a common standard, added etc., and very gradually the world of space as we now know it is evolved. An admirable rehearsal of many facts of visual space is made in an attempted refutation of Helmholtz' statement that the present sensation is a sign the interpretation of whose meaning is left to the understanding. This James declares is irreconcilable with all his sensationalism and insists that the understanding does nothing but recall, and produces nothing. This space chapter is one of the best in the book, but in the latter point falls short of carrying conviction.

Ch. XXI. The sense of our own bodily existence is the nucleus of all reality or belief. Any object which remains uncontradicted is *ipso facto* believed and posited as absolute reality. Real things are reductives of things judged unreal. (Taine.) There are seven orders of reality or worlds to which all gets referred. Reality coerces attention, stimulates will, is vivid, rouses emotional interest, etc. The objects to be chosen as realities are still under debate, but the perfect object of belief would be a God or soul of the world, good and explaining our experiences. This would account for all science and history in the deepest and simplest way. The primitive impulse is to affirm and doubt arises later. By acting as if a thing were real we can make it so for us. Will and belief are the same. The moral "improvements" of this chapter are interesting and impressive.

In Reasoning we pick out essential qualities first from recepts or generic ideas. An extracted character suggests a consequence more than does the whole object. Genius extracts fitting characters. The sagacity of animals is all accounted for by contiguous association while man associates by similarity. Genius does so in a great degree. This is a very inadequate chapter, abounding in animal stories, definitions of a gentleman, difference between men and women, and in view of the treatment this subject deserves, is not worthy of serious criticism. It is mainly an old paper printed under another title a dozen years ago.

A brief physiological chapter is inserted to illustrate how every feeling produces a movement with wide reverberations. Knee-jerk, sweat glands, bladder, bowels, uterus, circulation—all being affected.

The transitiveness of instincts and their inhibition by habits is shown, and this is followed by a description of a number of human instincts. Instincts conform to the reflex type, the nervous system being a preorganized bundle of such reactions. Only a mind debauched by learning can ask for the why of any instinctive human act, II, 387. It is mainly a mere excito-motor impulse due to a pre-existent reflex arc. Man has all the instincts that brutes have and many more concerning which there is much good æsthetic writing. The author is intent on contrasting rather than paralleling human and animal instincts. Instincts shade imperceptibly into emotions which are consequences not causes of bodily expression. They cannot be divorced from sensational processes. Abstract the bodily symptoms from any strong emotion and

it goes with them. It seems to be even admitted that a totally anæsthetic person could have no emotions. The objections that we may act emotions and not feel them, and that expressing emotion checks it are in our judgment not at all met, and to hold that emotions are due to inhibited reflex and impulsive tendencies, would be nearer the truth. Some emotions the author holds can be explained but many, "nay the entire æsthetic life of man" is of accidental origin—love of music as well as sea-sickness, etc.

Will, Ch. XXVI, acts on the ideas of many movements left in memory by the reflex performances of our automation. It can reconstrue these elements but create no new ones. The kinæsthetic idea of what the act is to be is made of memory images of afferent sensations arising from previous motions. Feelings of out-going energy or of innervation are denied (Münsterberg), first on a priori grounds. Introspection also does not find them. We only anticipate the sensory consequences of movement and there is a fiat that these shall become actual. Thus sensationalism is made rich, not degrading, and spontaneity and choice are reserved for spirit, II, 518. Even the visual or auditory effect of a movement may be its mental cue. Sometimes the mere thought of a movement is sufficient to produce it if there is no conflicting notion, and it always tends to do so, as in mind-reading. In deliberative action there are five types of decision. Consciousness in its very nature is impulsive. Pleasure and pain are not the only springs of action, and effort of attention is the essential phenomenon of will. Will is the relation between the mind and its ideas. To these the will is always directed and the only resistance we can feel is the resistance an idea offers to being attended to at all. Consent is to fill the mind with an idea. The sense of effort, which appears in the fourth and fifth types of decision, brings us to things metaphysical and spiritual. While as a science psychology may hold to determinism and thinking as an immaterial process *goes on*, it is effort-choices that bring in the wider order on which science has no claim and which lead the author to declare for freedom. Yet free will involves only the *amount* of effort of attention.

After a chapter on hypnotism which is evidently very hastily written and is meager and inadequate, comes the long and final key chapter of the book on necessary truths and experience. Elementary feelings are innate, so it is their combination that is involved. The mind has a wealth of native forms, pre-established relations, ideal inner pure apriori rational principles, concerning which we can know nothing save that they did not originate from experience. These embrace *pure* sciences, all of which are exclusively results of comparison, such as classifications, all judging, predicating and subsuming, number relations and geometrical form, metaphysical, æsthetic and moral principles. To argue that these are in any way dependent on individual or ancestral experience is untrue, and so unintelligible that it is hard to understand how such shallow and vague accounts of them as Mill's and Spencer's could ever have been given by thinking men." The attempts of Helmholtz and others, to connect geometric axioms with experience is not here referred to, perhaps because the vocabulary of denunciation is exhausted. Experience is restricted to time and space and these are no less arbitrarily narrowed to their very lowest range and potence. All necessary truths, higher powers, and even all natural science, arise as "back-door processes" which modify the brain but give no cognition of themselves as opposed to experience, or impressions from something foreign (as natural objects to which the mind is passive and fatally servile). "Back door" is Dr. James' term for Darwin's accidental variations or Spencer's indirect equilibrations which are due to autogenous brain growth. Here belong freaks, sports, flashes of wit, and of dis-

coveries or lucky fancies, susceptibility to music, sea-sickness, drunkenness, the temperament of genius, idiosyncrasy, as well as love, pleasure, pain and elementary sensations. All enter by the "back-door." Necessary truths are products of these accumulated spontaneities. They are as by divine fiat, or even deity could give no explanation of them; some of them are barren and abstract and verbal enough in their "pure" forms to have little interest save to a sublimated scholastic mind, and in fact are treated in extenso here in violation of the author's own worthy purpose in his preface to keep metaphysics out of psychology. But when he brings into this transcendant realm of necessary truths of which we know nothing save that they are absolutely independent of all repetitions or ancestral experience, all the choicest results of science which were attained by breaking away from mere experience, which is a chaos of fragmentary impressions of sense, which we can never know as they are to the ideal world of atoms and molecules, etc., which can be of moral and æsthetic truths which cannot be tested yet which we hold to as a creed, and which itself is finally said to have nothing to do with experience save to coerce facts of sense under its rubrics, and to be so supernally rational that even cause seems but an altar to an unknown deeper connection; we realize with sadness and regret how remote from most ideals and endeavors of empirical science in this field this vigorous and able writer has cast his anchor. If Weismann's atavism, and the mixing of sperm and germ cells early separated from somatic cells, concerning which morphologists are now about evenly divided, be true, the influence of the environment only becomes selective rather than causative. For Weismann variation is indeterminate and so far from accounting for anything necessary or eternal may conceivably give brain growth, or "back doo"r processes of a nature so entirely different that it is idle to speculate concerning any selective results. Both logically as well as historically, all schemes of necessary and eternal truths have more affinities with Lamarck or pre-evolutionary fixed types and species. It is idle to affirm whether the same truths or very different ones would issue from other lines of evolution.

Passing now to *the work as a whole* the author might be described an *impressionist* in psychology. His port-folio contains sketches old and new, ethical, literary, scientific and metaphysical, some exquisite and charming in detail and even color, others rough charcoal outlines, but all together stimulating and suggestive, and showing great industry and great versatility. The important works of art and science have usually been done by men who sink their personality in their work. These traditions of self-effacement are effete for our author, who tells us incidentally of his age, of his early school life, his daily habits, tastes, etc., and unintentionally compels the reader to imagine that he is the hero of many more of his stories and illustrations than is probably the case. His favorite theme, conscious states, also contributes to give the book in places a Rousseau like—we had almost said Bashkertsieff like—confessional flavor. Its personal frankness, which also accounts for such denunciatory epithets for divergent psychologists as we have quoted, is unequalled in the history of the subject. Indeed so saturated is the book with the author's personality even where he is not consciously recording a "personal confession," or a bare "opinion" as in I, 396, that those who do not know him will misconceive much in it, while for those who have known him it will be the key to a personality of rare accomplishments and attractions, as well as no less rare frankness.

The passing thought, feeling, or sensations or in a word *conscious states* are the basis of all. The spacial *quale* originates in a feeling of crude extensity involving all three dimensions. Time is rooted in a

feeling of succession or elsewhere a feeling of duration. Imagination differs from sensation mainly in intensity. Comparison rests on difference-sensations and may involve a feeling of difference-sameness. There are also relation feelings, and these are involved in perception which is a larger sensation. The components of voluntary motion are anticipations of the sensory consequences of the movement and a feeling of effort. These cannot be analyzed or classified. They are as ultimate as necessary truths concerning which it is as idle to speculate, as concerning instinctive and reflex acts. Only a mind "debauched by learning," or as the fakir would say, II, 641, learned in the things he cares not for, would examine to these idola. Emotions rest on bodily sensations and are as unaccountable as accidents, sports, freaks, "back door" processes or sea-sickness, love of music, or the taste of lemonade which is not made of sugar or lemon, but is a new independent sensation.

States of consciousness are the warp and woof of all. No anatomist ever loved to trace tissues more than Dr. James delights to dissect these states in their ramifications. They are described from all moods and in all manners, and dilated upon as fondly as "the water that comes down at Lodore," or as a programist grasps in all directions for tropes to describe in words the nature and effect of each phrase of a sonata. He has a veritable genius for turning inward and catching these states on the wing, and for describing them graphically. Thus he makes of introspection not dogma but literature as it should be; literature not only very rarely dull (which is saying much in this field), but often highly spiced with well stored anecdotes, *bonmots* and sudden surprises, and not infrequently delightful and almost superb. In pursuit of these he is led farthest from the main line of his argument and it is novelties both of thought and expression here that are most striking and will linger longest in the reader's mind. Conscious states flow along now slowly, now rapidly, now perching, now flying. They associate themselves, summate past states, are herded, massed into an unitary object for a thought which may have become a thinker, or even a self. These are in closest apposition to brain states and to objects, mediating between these and soul *per se*. It is these that are real enough to act causatively upon brain molecules. This general standpoint sometimes called phenomenalism in Hodgson and Renouvier becomes as we said, impressionism in Dr. James. No two states can be the same, it is repeatedly said, and it is impossible to make any exact coherent statement of Dr. James positions. There are passages where these seem the only reality and not only human faculties, but soul, outer world, brain included, seem to have no reality save that which these confer, but this is by no means the dominant standpoint. His external world is not lacking in reality at least from the psychological standpoint.

In closest relation to feelings and to conscious states are brain states or neural processes. Although the usual chasm of incommensurability is emphasized, these play a rôle second only to consciousness itself. Perception is called a brain-product. So are all the "back door" spontaneities. Contrast is physiological and not psychological. Memory and recollections are the habit of the nervous system, and so is association, imagination, hallucination, instinct and spontaneous attention. The nuclear self is made up of its tensions and re-actions, and emotions are consequences not causes of bodily activities. All the movements from which the will selects are preformed in it. The combination of vibrations into musical tones is a nervous mechanism with no psychic synthesis involved. Pflüger's "spinal soul" is also due solely to mechanism. In short the "feelings" and "states" of all sorts spring out from the brain, which no physiologist would ever think of invoking so continually as a *deus ex machina*. From a description of it in chapter II and

III no one could suspect the rôle it plays later. When it is invoked to explain one group of phenomena, we are told of "currents once in which must find a way out," etc., I, 107–9; elsewhere, to explain another group, of the "cumulation of brain processes overlapping," I, 635; for yet another purpose of a "new and more violent sort of disintegration of neural matter, which now explodes at a deeper level"; or to explain the difference between sensation and imagination of an "inward molecular cohesion in our brain cells which it probably takes a sudden inrush of distructive energy to spring apart," II, 74. When a certain intensity is reached we are told that a new order of resistance arises which must be broken by a new order of force from without. We are told of "pontificial cells," of "drainage channels," "paths scooped out," "gutters," of "blocks" in the same, of "tensions" and "equalizations between any two points;" of "isomerisms" and "changes merely chemical;" of "traces," "copies" and "images;" of "glows," "tremors," "tingles," "flashes," and explosions; of "tenacity of brain substance" and "of its plasticity;" of points that "wake each other up," or how motions can become feeling, I, 146. And yet "no phrase our lips can frame is so devoid of apprehensible meaning." To use one hypothetical generic process, as Jackson uses the figure of explosions to explain epilepsies, as Meynert uses association fibres, or Spencer isomerism; or as many physiologists use electric currents, etc., or to speak in large over-all terms of neural changes, modifications and disturbances, etc., is often done in our speculative efforts to bridge the "chasm." But if we must still have tentative or provisional, physical and chemical imagery, let them be clear and consistent. Such a jumble of processes extemporized in this loose literary way are possible only in just the mental limbos physics and chemistry exist to clear up. They explain everything equally well because they explain nothing, and harmonize no better than would a random collection of choice religious imagery concerning another world and state. This is about as far from "untrameled homogeneity of terms" as can well be imagined. Such brain matter is indeed "an instrument of possibilities but no certitudes," 141. For our part we should now prefer to check this exuberance of meta-neurology, not more out of respect for the "chasm" than for recent or present morphological advances that almost inspire the hope that the beginning of the end of this degenerate interregnum is at hand.

III. Besides the many apriori feelings or conscious states and the brain states and processes, Dr. James' psychology does not drop the soul. He says he "shall take no account of soul," I, 181–2, yet adds: "I confess, therefore, that to posit a soul influenced in some mysterious way by the brain states and responding to them by conscious affections of its own, seems to me the line of least logical resistence." On this mysterious soul the separate brain processes would combine their effects. Soul is a "much despised word," but we cannot despise the great traditional beliefs that tow us soulward. All thoughts are owned. No psychology can question the existence of personal selves. We do not personify the procession of thought, but it is already personified.—I, 226-7. The ego is felt with and connects thoughts, 242. If things are to be thought together it must be in one something, although "we will not discuss the ego just yet." "I do not wish just yet to commit myself about the existence or non-existence of the ego," although it is not needed to unite Kant's manifold," p. 177-8. The physical adjustments are not all of the self of selves, but whether the *thinker* or pure sciousness immanent in each section of the thought stream, be a logical postulate like pure matter, is a metaphysical question. This is, however, a "parenthetic digression," from which the author "reverts to the path of common sense," while the obscure feeling of some "self above

the adjustments," etc., such as "subjectivity as such, of thought become its own object," or an "indivisible active soul substance" is left open.—303-5. Is the "inner nucleus of my spiritual self" the adjustments plus "a still more obscurely perceived subjectivity as such?"—319. Common sense drives us to admit an "arch ego," or at least a shepherd of past states, uniting and owning them, but perhaps itself owned in dying by another which may be the present thought vested for the nonce with synthetic power.—338-9. The popular notion of a simple, incorruptible soul is needless for explaining the phenomena "of consciousness which are all accounted for by the power of each thought in the stream to know and appropriate the others' content, and personal identity is only a perception of sameness. Of the essence of mind we know nothing. Soul is a superfluity even for forensic responsibility before God, and gives no immortality save an atom-like simplicity we do not care for. It explains nothing and guarantees nothing. The author is "free to discard the word soul from the rest of this book" save in the vaguest and most popular way, "an *anima mundi* is more promising."—I, 342-50. Yet the effort to attend may be an original force, and the auther counts himself among "the believers in a spiritual force," although his reasons are all ethical and "hardly suited for introduction into a psychological work," I, 454. [See also 499, 51]. "A presiding arbiter" seems set aloft in the mind and distinguishes good from bad thoughts as they arise, related to the latter as ethics to history. Omitting intermediate allusions, we are told later, II, 518, where to draw "the true line between passive material and the activity of the spirit." Again, II, 574 5, "what the heave of the will betokens metaphysically, and what the effort might lead us to infer about a will power distinct from motives, are not matters that concern us yet." "Questions as momentous as the very existence of spiritual causality, or vast as that of the very existence of universal predestination, or free will depend on its interpretation," *i. e.* of effort. "How thinking exists as a special immaterial process along side of material processes," the author does not fully understand, 571-1, and decides for freedom; "but since the grounds for his opinion are ethical rather than psychological, he prefers to exclude them from the present book," 573.

Such scattered references, to which must be added the one quoted, I, 696, concerning the spirit of the dead French doctor, it is impossible to co-ordinate. This outspoken writer becomes strangely timid, apologetic, self-conscious and self-contradictory here. He recurs over and over again to this in the form of "ultra cerebral conditions," "transcendental thinking agent," the "I that knows the me," the same brain subserving many conscious selves," nowhere stalwartly asserting his pneumatology, but ostentatiously refusing to ring up the transparent metaphysical curtain behind which it is usually seen,and playing bo-peep with it with if, but and perhaps. That he is even unconsciously all through the book only building a new stage and setting a fit scene in modern sciencetown for the old timeless, spaceless, deathless soul of eschatology, we have no right to say in view of the many unwonted, masked reserves, but every intelligent reader will see not only that there is nothing inconsistent with this view, but that this is the only possible standpoint from which the book has unity or cohesion. Deny the knowledge of passing thought, a matter left very dark by the author, and we must have a soul to mediate union between psychic elements. *Seelensucht* is the key to what is left undone as well as to what is done. His abhorrence of mind-stuffists and associationists, the slight treatment of instinct, memory, and the lower senses, the special lines of interest to which he confines himself in treating vision, hypnotism and automatism, the almost total omission of pleasure and pain, of hearing, touch, taste and smell, and of anthropological psychology, and the

strange neglect of fundamental biological principles, etc., are now all explained. Some of the most lusty branches of the psychological tree are neglected or mutilated in the interest, consciously or unconsciously, of the author's strong undertow of animistic propensities. We, too, believe in soul, but not in a way which interferes with causation or the conservation of energy. As consciousness, he thinks, need only tip molecules, so soul needs, it is pleaded, only to prolong the fixation time of spontanious attention. If consciousness can tip molecules, what of the "chasm" so orthodoxly emphasized between brain and psychic state; may it not tip a table, at least if it be accurately enough balanced; and how is its force applied, or is the brain "boxed and blanketed" like a medium's cabinet to cunningly defy our peering curiosity; was it with this consciousness that physical miracles of old were wrought; can it act telepathically? There is at least nothing against any or all of these. To appeal to consciousness as a physical cause is to invoke the chaos and old night of spiritualism. Holding firmly to the views of it we expressed in the first number of this journal (see vol. 1, No. 1, p. 145), we cannot accept the smallness of this baby (I. 144), as any excuse for its illegitimacy or its depraved heredity.

This is through and through a "tendence" book. Its very inconsistencies and incoherencies not only reflect but greatly magnify all the unrest, distraction and conflicts of the present hour. The author is a veritable storm-bird, fascinated by problems most impossible of solution, and surest where specialists and experts in his own field are most in doubt, and finding it very hard to get up interest in the most important matters, if settled and agreed to, even to state them well. Open questions haunt and taunt him, and sometimes become almost neuroses. Although his partizanship sometimes lacks poise, repose and even philosophic dignity, yet in its most extreme and blinding intensity it often becomes almost magnificent, even where it is neither science nor philosophy. Assuming as the three fundamental postulates whose foundations he will not explore, brain states, conscious states and an ulterior self, and abhorring as the very powers of darkness from the pit the words unconsciousness, unknowable, if not even unknown, in all their application, his gnostic passion will not be put off with any appeal to an higher and future synthesis. All this is "spiritual chloroform," a "device for making a luxury of intellectual defeat." "Better live on the ragged edge, better gnaw the file forever," even though this be a "constitutional infirmity."—I, 179. Where can be found a better type of what Hegel's phenomenology characterizes as the stage of "unhappy consciousness?" This distraction is reflected in the form and style of the book, which is at every point in no less strange contrast with the work of the ordinary text-book maker, than it is with the patient investigations of the laboratory, which must seem both alike tedious to such an author. There are many brilliant and original pages, hundreds of pages of admirably selected quotations and translations, a large train of footnotes and afterthoughts, often most happy and helpful, and often undigested and unassimilated, representing successive stages of ripeness or information, so that occasionally errors carry their own medicine on the same page (*e. g.*, Wiesmann's corrective, not realized, of necessary truths; G. Allen's point about idiosyncrasy, 631, or Romanes, 678, the bearings of which are not fully seen or felt.) The book could have been somewhat lessened in size had the author recorded the results of private thinking instead of so often writing himself clear. The further transformations of change and growth, which are not complete, or the further adjustments between the three principles may considerably revise the present conclusions, and we shall await the author's metaphysics and ethics with interest later. The ripeness, repose and perfect mental digestion of Lotze, who abhorred every

flavor of rococo, eclecticism or extravagance of expression; or of our own Charles Peirce, who burns his own smoke, and talks with the rifle rather than with the shot gun, or water hose, are most contrasted with this author, and most desired in this confused and distracting field.

For our part we do not wish to balance and foreclose accounts between brain and soul yet. Even to attempt this just now, when from the neural and also from the psychic side both change, progress and promise are greater than ever before, is worse than waste, it is philosophic and scientific precocity and lack of self-control. But to force an adjustment between mind and matter by excluding all psychic elements from the simplest forms and functions of organisms, and making a Cartesian surrender to physiological mechanism, calculated to lessen psychological interest in these fields, on the one hand, and ascribing a causative agency to conscious states in a way to interfere with the conservation of energy and the belief in the perfect reign of law and order in the brain on the other, is, we believe, bad science, bad philosophy, and bad religion. In place of this tortured and tortuous dualism, or triadism, both tendency without and temperament within incline us to repose in faith in a future monistic synthesis, in which both law and freedom, mind and matter, immanence and transcendence will lose their partial aspects and stand revealed as parts of a sublime whole. The last few years have seen great changes in the spirit and temper of scientific workers, and all the currents set in this direction. Whatever may be true of the routine professors, or of the popular writers, it may already be said (in the direction of the phrase "the undevout astonomer is mad") that scientific investigation discovers, and men of real research work, with a spirit of reverence, and a sense of unity and law at the root of things and pervading every action and corner of space, that is religious to the core, in every sense which the best philosophy of religion makes basal. They live and work, often in obscure places in the field of science, animated by belief in future syntheses, both small and great. If the ultimate synthesis be monistic, it need not be so much the monism of contemporary schools as the modern psychological and even ethical equivalent of the sublime monotheism of the Old Testament, liberally and reasonably interpreted. Psychology, we believe, is even to be the means of rescuing religious oracles from degredation and re-revealing them as sublime ethnic verbal editions of God's primative revelation in his works. It will also show what is in man, and may some day become veritable anthropology, the science of man in fact as well as in name, a gospel of love and work, where the heart is not subordinated to the head, and the emotions are not slighted, or the great ethical lesson of hereditary good and ill, psychogenesis and adolescence doubted and disparaged. Instead of the modern degenerate and exiguous forms of the originally most stimulating "theory of knowledge" now grown so scholastic and debilitating if not positively harmful in occasional teachers, pupils and institutions in ways we shall try to describe later, the new psychology of the present and future is based less upon introspection than upon observation, experiment and experience, individual and ancestral. *Sum, ergo cogito*, might have been one of its texts. The text-books it needs are illustrated by Jastrow's recent little hand-book concerning reaction times, in which the main facts and conclusions in the field are conveniently presented and not scattered among the various speculative questions on which they are thought to have bearing. This method involves more labor with details and is plainer and humbler, but it is this method of self-control and subordination, carefully adhered to also by this Journal, that has commended the scientific method in psychology to the confidence of conservative administrative boards, and by which its recent remarkable academic extension in the universities and colleges

of this country have been made. It is premature speculative views that these boards justly fear. A book so individual in its style and method will inevitably invite attention more and more to the personality of the author, it is just these elements and idiosyncrasies that will be valuable material for the inductive methods of the future in psychology.

In what we have said we have been guilty, however, of looking a gift horse in the mouth. Many were too busy with enlarging the field by investigations; others lacked the range of view, or literary style, so that the advent of a good text-book maker has been longed for. Dr. James lacks the just proportion of Professor Ladd, but opens to the English reader much new ground, and his familiarity with many of the facts he does describe is greater, but they are strung on theory like Dewey (as they are not in Ladd, whose objectivity is admirable), and there is much less vituperativeness than in Bowne. Dr. James is, however, more stimulating and suggestive than any of them. His breadth and breeziness and large philosophy and comparative standpoint is now one of the chief needs in this field. Even to attempt to harmonize old and new, science and introspection is an inspiration. Those subjects that are treated *con amore* are admirably presented (as *e. g.* the optical parts), and there is a literary form that sets off everything which none of the rest can equal. The author's experience as a teacher has been long and varied; his love of his subject is deep. His acuteness and vigor of intelligence and independence are rare. From dryness and routine he is as far as it is well possibly for a professor to be and still keep in academic traces. Moreover, this is not one work among many of a worn writer, but however much he may write later, this will remain the one life book of an able, well-trained and mature man, who has gathered himself well together, re-edited all former papers, balanced accounts with the literature on his lines well up to date, and here deliberately indulges not only without reserve but with *Ausgelassenheit* in what Lotze called the supreme felicity of self-expression, which temperament, power of language, and his favorite subject of selfhood and psychic state combine to make as full and utter as self-expression can well be. Both merits and defects were never more extreme. The critic must blow hot and cold, because "where it is good it is very good and where it is bad it is horrid." The good, however, is so very largely preponderant that many if not most of the gravest errors and defects might be eliminated in a radically revised edition. It is in the earnest hope that this will be done that we have dwelt so fully upon them. There is too little claim put forth for originality in some fundamental matters, and the combination and proportion of parts could not help being new in many particulars. We are glad to give to an effort we have ourselves found so stimulating the space at least it deserves. It marks a distinct advance in the teaching and study of the subject in this country. It is on the whole and after all the best work in any language, and we earnestly advise every one with the least interest in psychology to own and study it.—[ED.

NOTES.

THE PSYCHOLOGICAL SOCIETY OF MOSCOW.

By Prof. Nicholas Grote.

The Psychological Society of Moscow has 180 members (10 honorary members—Bain, Sidgwick, Zeller, Wundt, Helmholtz, DuBois-Reymond, Ribot, Richet, and two Russian professors, with Mr. Troitzky, the founder of the society). It was founded in 1885. The first president was Mr. Troitzky, who was succeeded in 1888 by Professor Nicholas Grote of the University of Moscow.

The society was organized for the discussion of problems in psychology, its foundation, theory, applications and history. It has also discussed problems in philosophy, logic, morals and the philosophy of law, esthetics and pedagogy. More than fifty meetings have been held, (thirty-seven of which were in the years 1888–90). Thirty members of the society have made 62 communications. Of these, 10 referred to the history of philosophy, 25 to problems in psychology, 7 to hypnotism and psycho-physics, 5 to ethical subjects—including a communication from Count Leon Tolstoi on the the problems of life,—besides papers on metaphysics, methodology, esthetics, psychiatriy, etc.

Since 1888, the society has published three volumes of its Transactions; one volume on the Philosophy of Schopenhauer; one volume of Translations of the Prolegomena of Kant, and one volume of six communications on the Liberal Arts by different members of the society. We are now engaged upon a fourth volume, Translations of Certain Philosophical Works of Leibnitz.

Since Nov. 1, 1889, I have founded, under the auspices of the society, the journal, "Problems in Philosophy and Psychology," devoted to original contributions, critical and historical, on the different questions in philosophy. From four to six numbers are published during the year, and the subscription list already contains 1400 names. It has been very favorably received, both by the members of the society and by the Russian press. The journal is edited by Mr. S. Abricosoff, a member of the society.

Each year, on the 24th of January, the society holds a meeting to which the public are admitted, when from 500 to 700 people assemble. The other meetings are sometimes open and sometimes closed to the public. The communications are discussed at length, the meetings lasting from three to four hours. The members are specialists in their lines. There are 30 each in philosophy and medicine, and 20 jurists, besides historians, philologists, mathematicians and naturalists. In addition to these, there are 30 amateurs who are associate members only.

The editors of the *Zeitshrift für Psychologie* have added to the usefulness of their already valuable periodical, by appending to it an extended bibliography of recent literature on psychology and related topics. This they propose to do annually. The present installment for the year 1889 covers with its analytical table of contents and its alphabetical index of authors some fifty-six pages and eight-hundred and ninety-nine items. Somewhat of the scope of the undertaking appears from the headings of the fourteen general sections into which the literature is divided. 1, General; 2, Anatomy of the Central Nervous System; 3, Physiology of

the Central Nervous System; 4, Sensations in General; 5, Physiological and Psychological Optics; 6, Physiological and Psychological Acoustics; 7, Other Specific Sensations; 8, Perception of Space, Time and Motion; 9, Consciousness and the Unconscious, Attention, Sleep; 10 Practice (*Uebung*) and Association; 11, Ideas and Idea-complexes; 12, Emotions; 13, Motions and Actions; 14, Neuro- and Psycho-Pathology. Most of these are further divided into numerous sub-heads. Taken altogether, the bibliography is a most impressive witness to the present activity in psychology and closely related lines.

To the Editor:

May I ask your aid in making the following announcement? A grant has been made for the equipment of the laboratory for experimental psychology at the Toronto University, and I should be glad to correspond with students or investigators who are projecting researches in any branch of this subject. Apparatus which they need may be purchased from this grant, to be used by such investigators in the laboratory. The intention is to make the laboratory as useful as possible for the advancement of the Science, and it is thought that this utility may be best served by aiding a few who may be hindered in original research by lack of facilities.

The appropriateness and importance of such researches and the advisability of undertaking them under this grant will, in each case, rest with the Department of Psychology here.

If in time the results should warrant it, I assume the responsibility of saying that the expense of publishing them will be met by the Department of Education of the Provincial Government. Application should be made as early as possible.

Yours truly,

PROFESSOR J. MARK BALDWIN,
Toronto University,
Toronto, Ont.

INDEX.

ORIGINAL ARTICLES.

THE INSANITY OF DOUBT. *Philip Coombs Knapp, M. D.* 1.

THE EFFECT OF FATIGUE ON VOLUNTARY MUSCULAR CONTRACTIONS. *Warren P. Lombard, M. D.* 24.

STUDIES FROM THE LABORATORY OF EXPERIMENTAL PSYCHOLOGY OF THE UNIVERSITY OF WISCONSIN. *Joseph Jastrow, Ph. D.* 43. On the Psychophysic Series, 44. The Perception of Space with Disparate Senses, 49. On the Pressure Sense, 54. On Just Observable Differences, 57.

CHILDREN'S LIES, 59.

A SKETCH OF THE HISTORY OF REFLEX ACTION. Introduction, 71. Continuation by *C. F. Hodge, Ph. D.* 149, 343.

A SIMPLE AND INEXPENSIVE CHRONOSCOPE. *E. C. Sanford, Ph. D.*, 174.

OBSERVATIONS ON COLLEGE SENIORS AND ELECTIVES IN PSYCHOLOGICAL SUBJECTS. *E. A. Kirkpatrick*, 168.

ON THE BRAIN AND SENSE-ORGANS OF LAURA BRIDGMAN, *H. H. Donaldson, Ph. D.*, 293.

ON A CURIOUS VISUAL PHENOMENON, *Joseph LeConte, M. D.*, 364.

A COUNTING ATTACHMENT FOR THE PENDULUM CHRONOSCOPE, *William Noyes, M. D.*, 367.

AUTOMATIC MUSCULAR MOVEMENTS AMONG THE INSANE, *C. P. Bancroft, M. D.*, 437.

ON THE PSYCHOLOGY OF TIME, *Herbert Nichols*, 453.

ON THE RECOVERY OF STIMULATED GANGLION CELLS, *C. F. Hodge, Ph. D.*, 530.

PSYCHOLOGICAL LITERATURE.

Abnormal Psychology: Case of hallucination, 435; census of hallucinations, 292; hallucination of the muscle-sense, 137. See also, Morbid Psychology.

Anthropology, 270, 272; criminal, see Criminal; of birth, 262; of the sex relations, 253; animism, 272; folk-lore, 270, 271; mental tests, 383; poisoned arrows, 271; primitive architecture, 271; school anthropometry, 291.

Association, 144, 384.

Attention, 130, 382.

Charities, 397, 403; endowed, 402; scientific, 403; causes of poverty, 401; public relief, 397, 398.

Children, experiments on, 435; movements of, 273; results of physical examination of, in schools, 291.

Comparative psychology: Anatomy of compound eye, 189; physiology of the insect eye, 208; perception of light with the skin in blind *proteus*, 211; micro-organisms, 108, 126, 128.

Craniometry, 228, 235, 238.

Criminology, 114-126, 219-240, 385-405.

Crime and epilepsy, 121; and genius, 221; and hypnotism, 125, 223, 224; and inebriety, 125; and insanity, 120; chronicles of, 124; among the creoles, 230; in Brest, 389; in France, 388; in France and Italy, 231; crime and society, 386, 391; statistics of, 122, 123, 389.

Criminality, theories of, 120.

Criminal psychology, 120, 121, 239; criminal type, 117; criminals, 393, 395; and society, 118, 119, 124; anthropometry of, 220, Bertillion's system, 123; born, 385; cerebral anomalies of, 236, 237; cranial anomalies of, 235, 236; effect of environment, 118; physical and psychic peculiarities of, 115, 116, 231; physical training of, 123; recidivism, 122, 391.

Murder, psychic contagion of, 228; mutilation of victim after, 229.

Penology, 117, 122, 124, 386; civil reparation, 387; crimes and penalties, 124; death penalty, 390; electrical execution, 126; forced labor, 387; incorrigible criminals, 388; International Penal Law Association, 386; German section of, 388; punishment of young criminals, 387; reduced responsibility, 148.

Prisons and prison systems, 124, 234, 235, 240; female life in, 240.

Reformation of the criminal, 394; indeterminate sentence, 233; reformatories, 121, 240.

Education, 272; of Laura Bridgman, 273, 430; sex in, 259; results of physical examination of school children, 291.

Emotions, 111, 112; courage, 434; love, 252, 253.

Experimental psychology, 126–137, 197–212, 377–385, 572–578. Circuit of consciousness, 431; contrast as the result of adaptation, 133; crystal vision, 136; mental tests, 383. See also, Physiological psychology, Psychophysic law, and Senses.

Fatigue, 377, 379; of nerve fibres, 556.

Heredity, 97–114, 241–266; and alcoholism, 404; and marriage, 262; and pauperism and crime, 261, 399; inheritance of acquired characteristics, 104. See also, Sex.

Hypnotism, bibliography of, 429; and crime, 125, 223, 224; treatment of dipsomania by, 404.

Illusions, 207, 433, 573.

Memory for series of sounds, 290; time-relations of the memory image, 274.

Miscellaneous: 139–143, 266–275, 429–432, 578–591; Biological problem of life, 142; Ethics of evolution, 431; Genius, 221; Homeopathy, 431; Ideas of phantasy, 139; Law of imitation, 267; Social problems, 403; Transactions of Assoc. of Amer. Physicians, 96; Philosophy, 266; history of, 270; Proper names in medical nomenclature, 148; *The Monist*, 430; *Zeitschrift für Psychologie*, 287, 433, 592.

Morbid psychology. Diseases of the encephalon: Anæsthesia from cerebral lesions, 87; aphasia, 289, 565; cerebellar tumor, 375; hydrocephalus, 89. Diseases of the spinal cord, 553.

Idiots, brains of, 89, 90, 91; cranial anomalies of, 228.

Inebriety, 125, 226, 389, 403–405; alcohol and heredity, 404; effect of, on the brain, 227; dipsomania, 405, treated by suggestion, 404; responsibility of drunkards, 404.

Nervous diseases and diseases of the sex organs, 250; ataxy, 433; hysteria, 135; causes, 137; hysterical anæsthesia, 135; trophic lesions, 96; neuroses and pessimism, 138.

See also, Abnormal psychology, Nervous system, and Psychiatry.

Nervous System, 87–97, 182–197, 371–377, 544–557; histogenesis of, 544; comparative anatomy of, 92; neurokeratin, 191. Central nervous system, anatomy of, 557; comparative physiology of, 182; histological methods for, 94, 95, 192.

Encephalon: Anæsthesia from cerebral lesions, 87. Brain, abnormalities of, in idiots and imbeciles, 90, 91; comparative anatomy of, 193, 376, 377, 552; effect of alcohol on, 227; nomenclature of, 557; brain physiology and psychology, 550. Broca's convolution, 372. *Callosum*, sectioning of, 376. Cells and fibres, 192. Cerebellum, anatomy of, 546; loss of fibres in, 87; cerebellar tumor, 375. Cerebrum, arteries of, 89; dogs without, 88; acquired cerebral defects, 552. Cortex, degenerations following lesions of, 189, 376; functions of, 553; origin of, 552. *Chiasma*, 375. *Cingulum*, 553. Fissural diagrams, 373; fore brain in the embryo, 193; frontal lobes, anatomy of, 371. Localization, 188, 373, 374. Oculo-motor nerve, number and size of fibres in, 94; nucleus of, 93; optical centre and eye-movements, 373; sensory fibres in the encephalon, 87; *Striæ acusticæ* and *lemniscus*, 549.

Spinal cord, anatomy of, 547; comparative anatomy of, 92. Columns of Goll, 553. Fibres in the spinal cord, 140. Knee-jerk, anatomical findings in loss of, 92. Ranvier's constrictions in, 555. Secondary degenerations, 555.

Peripheral nerves: Cerebral nerves, 93. Peripheral ganglia, 372, 556. Nerve fibres, 87, 94, 95, 556. Spinal nerves, 92. Trophic nerves, 96.

Notes, 144-148, 287-292, 433-436, 592-593.

Pauperism, 398; and crime, 261; and heredity, 399; statistics of, 401. Tramps, 402.

Physiological psychology: effect of circulation and breathing on psychic processes, 130, 135; knee-jerk, 92, 577; laboratory of, at Rome, 433; sleep, 136; speech, 289. See also, Children, Experimental psychology, Psychophysics, and Senses.

Psychiatry, 137-138, 212-219, 269, 406-429, 557-572; dangers of, to the physician, 148; effect of imprisonment on the insane, 148; craniometry and mental disease, 228; dipsomania, 405, treatment of by

suggestion, 404: ecstasy, 251; general paralysis, 557-572; alleged recoveries, 567; antisyphilitic treatment in, 568; aphasia in, 565; complications, 564; early stages, 557; manner of death, 563; ocular symptoms, 565-567; pathology, 560-563; surgical treatment, 569. Heboïdophrenia, 214. Insane: criminal, 148; in the county poor houses, 291; hallucinations of muscle sense in, 137. Insanity: and *mal perforant*, 564; loss of cerebellar fibres in, 87; New York State report on, 400; of Rousseau, 406-429. Katatonia, 212. Melancholia, 216. Menstrual insanity, 249. Morphinomania, 274. Paranoia, 217. Periodic insanities, 249. Psychic infection, 137. Sexual psychopathology, 251. Statistics, 216. Pulmonitis in paralytics, 565. Verbigeration, 137. *Verrücktheit* and *Wahnsinn*, 218.

Psychology, 430; and brain physiology, 550; in American Colleges and Universities, 275-286, Clark Univ., 284, Columbia, 277, Harvard, 278, Indiana Univ., 283, New York Col. for Training Teachers, 277, Surgeon General's Office, 280, Univ. of Penn., 281, Univ. of Neb., 276, Univ. of Toronto, 285, 593, Univ. of Wis., 275, Yale, 279; in Russia, 592; laboratory of physiological, at Rome, 433; manual of empirical, 140; object of psychological investigation, 139; of jugglery, 272; of prejudice, 272; Principles of (Prof. James), 551, 578.

Psychophysics, 433; in vision, 132, 209, 287; new method in, 209; Negative sensations, 288, 385.

Reaction-times, 134, 382, 577; time relations of mental phenomena, 274, 578.

Senses. Hearing: colors and tones, 206; illusions of, 573; interval-sense, 134; location of beats and difference tones, 383; space sense of the ear, 132, 572, 573.

Muscle-sense, 137.

Pain, 111.

Seeing: Acuteness of vision with colored lights, 381. After-images, 289, 290, binocular, 206. Binocular color-vision, 206. Color-blindness, 575, 576; peripheral, 204, 574; Colors after retinal fatigue, 575; and tones, 206; Hering vs. v. Kries on, 201; in indirect vision, 203, 574: contrast, 197, 200, 288, 574. Eye, comparative anatomy of, 189, 208; histology of the retina, 188. Optical illusions, 207, 433. Primary colors, 206. Retinal light, 287. Visual perception of space, 131.

Sensory control of muscular movements, 289.

Smell, 111.

Taste, organs of, 193, 195; sensations of, 434, 435.

Temperature, sensations of, 291.

Time-sense, 129, 211.

Sex and Heredity, 99-114, 241-266. Abortion, 263. Adolescence, 259. Birth-rate, 263; Cell, consciousness in, 109; experience, 99, 103, 108; physiology, 143; psychology, 108; somatic and reproduc-

tive, 102, 104, 105, 106; structure, 99. Fertilization, 100, 243, 265. Idioplasm, 99, 103, 108, 241. Karyokinesis, 101, 266. Köl-liker's theory, 103, 107, 109. Menstruation, 247, 248; menstrual insanity, 249. Nucleus, function of, 100, 109, 264. Origin of Death, 105, 106. Ovum, function of, 101, 103, 107, 243, 247, 248, 265, 266. Pangenesis, 101. Parthenogenesis, 103. Perigenesis, 99. Sex, among the protozoa, 242; and society, 261; determination of, 103, 243, 244, 246; in education, 259; relations, anthropology of, 253; Swedenborg on, 257. Sexual hygiene, 258 ff.; instincts, 252; psychopathology, 251. Spermatozoon, genesis, 100, 247; function, 101, 103, 107, 243, 248, 265, 266. Symbolism, 256. Weismann's theory, 102, 104-107, 109, 265. See also, Heredity.

Soul and Body, 110, 112; seat of, 110; Swedenborg on, 112.

Will, 134; voluntary movements in hysterical anæsthesia, 135.

II.—Names of Authors.

(The names of those who have contributed original matter are printed in SMALL CAPITALS.)

Acton, 260.
Albertoni, 206.
Allison, 148.
d'Arsonval, 126.
Aubert, 289.
Aubry, 228.
Axenfeld, 200.

Baker, 121.
BALDWIN, 285, 593.
Ball, 274.
BANCROFT, 437.
Barazer, 563.
Bartel, 249.
Battesti, 262.
Beevor, 553.
Benedikt, 236, 237.
Bérillon, 404.
Bernheim, 224.
Berthélemy, 564.
Bertillion, 123.
v. Bezold, 573.
Bianchi, 550, 565.
Binet, 108, 135, 251, 273.
Bournet, 231.
Boveri, 264.
Bowditch, 556; and Warren, 577.
Brabazon, Lord, 398.
Bramwell, 398, 568.
Brockway, 233.
Brooks, 101.
Brown-Sequard, 87.
Bruns, 93.
Brush, 235.
BRYAN, 283.
Burckhardt, 92.
BUTLER, 277.

Carnevale, 390.
Cassidy, 234.
CATTELL, 281, 383.
Cere, 435.
Charcot, 223.
Chaslin and Séglas, 212.
Chavasse, 260.
Chevalier, 251.
Chittenden and Kühne, 191.
Clark, 403, 405.
Clarke, 259.
Codrington, 271.
Colajanni, 226.
Cope, 110.
Cornill, 430.
Corre, 115, 230, 389.
Coutagne, 126.
Cramer, 137; and Tuczek, 89.
Cripps, 569.
Crothers, 125.

Darkschewitsch, 93.
Darwin, 101.
De Garmo, translator, 140.
Delbrück, 375.
Deschamps, 138.
Despine, 239.
Dessoir, 272, 429.
Dickinson and Langley, 372, 556.
DONALDSON, 87, 182, 293, 371, 544.
Dubois, 211.
Dugdale, 261.
Dumreicher, 577.
Düsing, 243.
Dwelshauvers, 382.

Ebbinghaus, 206, 287, 433.
Eberstaller, 371.
Edinger, 557.
Ejner, 211.
Ellis, 395.
Englemann, 262.
Evens, 403.
Exner, 208, 289.

Fajersztajn, 194.
Falkner, 123.
Fechner, 288, 385.
Féré, 119.
Ferree, 271.
Ferri, 391.
Fick, 574.
Finck, 253.
Flechsig, 192.
Folsom, 557.
Forel, 120.
Förster, 374.
Fothergill, 259.
France, 189.
Frommann, 94.

Gambara and Marimo, 235.
Garofalo, 117.
Gaule, 140.
Geddes, 107.
Gedœlst, 95.
Gley, 251.
Goldscheider and Schmidt, 435.
Goltz, 88.
Götte, 105.
Greppin, 95.
GROTE, 592.
Grinnell, 270.
Gruber, 100.
Grünhagen, 247.
Guinon, 137.

Hæckel, 99.
Hasse, 263.
Hegar, 250.
Helmholtz, 287.
Hering, 197, 201, 204, 288, 574, 575, 576.
Hertwig, 100.
Hervé, 372.
HERVEY, 277.
Herzog, 137.
Hess, 203, 574, 576.
His, 193, 544.
Hitzig, 110.
HODGE, 140, 149, 343, 530.
v. Hölder, 231.
Holmgren, 206.
Howe, 273.
Hyslop, 431.

Itelson, 433.

JAMES, 278, 292, 551, 578.
Janke, 246.
JASTROW, 43, 275, 430, 578.
Jennings, 256.
Jerusalem, 430.

Kahlbaum, 214.
Kapff, 261.
Kenny, 402.
Kirchner, 292.
KIRKPATRICK, 168.
Kirn, 148, 249.
Kitz, 259.
Klemm, 272.
KNAPP, 1.
Kölliker, 103, 546, 547.
König, 287.
v. Korányi, 376.
Köster, 90, 249.
Krafft-Ebing, 251.
Krauss, 121.
v. Kries, 572.
Kröner, 110.
Kühne and Chittenden, 191.
Kuhnt, 188.

Lacassagne, 229.
LADD, 279.
Lâhn, 148.
Læhr, 136.
Langley and Dickinson, 372, 556.
Laurent, 125.
LE CONTE, 364.
Legrain, 404.
Letourneau, 255.
Leumann, 135.
Lindner, 140.
Lipps, 290.
Loeb, 128.
LOMBARD, 24.

Lombroso, 116, 221, 386.

MacDonald, 114, 219, 385.
Mack, 431.
Maggiora, 377.
Mantegazza, 251, 253.
Marchand, 91.
Marimo and Gambara, 235.
Martius, 382.
Maudsley, 553.
McCormac, translator, 108.
McCulloch, 399.
Meigs, 555.
Mendel, 216, 560.
Meriwether, 402.
Meyer, A., 87.
Meyer, L., 563.
Möbius, 406.
v. Monakow, 549, 552.
Mooney, 271.
Morley, 406.
Mosso, 379.
Motet, 404.
Mott, 553.
Morrison, 120.
Müller, 269.
Müller-Lyer, 207, 209.
Munk, 373.
Münsterberg, 129, 130, 131, 132, 209, 384.

Nadaillac, 263.
Nägeli, 99.
Nakawaga, 552.
Napheys, 260.
Napoleoni, 118.
Nelson, 97, 101, 241.
Nichols, 453.
Niesser, 137.
Noyes, 212, 367, 406.
Nussbaum, 104.

Obregia, 373.
Oehrwall, 434.
Oelzelt-Newin, 139.
Oldenburg, 430.
Oliver, 565, 566.
Orano, 391.
Orschansky, 134.
Ottolenghi and Rossi, 385.
Oyarzun, 377.

Paneth, 274.
Patrick, 272.
Peck, 92.
Pelham, 124.
Perlia, 193.
Philips and Verney (eds.), 121.
Pick, 92.
Ploss, 263.
Porter, 555.
Pratt, 260.
Preyer, editor, 288, 485.
Prompt, 433.

Rabl-Rückhard, 376.
Radakovic, 433.
Reinach, 391.
Reitzenstein, 398.
Revington, 569.
Ridge, 227.
Rieger, 238.
Riggs, ed., 557.
Robinson, 240.
Roda, 218.
Rodriguez, 228.
Rossbach, 88.
Rossi and Ottolenghi, 385.
Roth, 105.
Rousseau, 406.
Rumpf, 433.

Sanford, 174, 284.
Sawin, 393.
Schaefer, 383, 573.
Schiller, 94.
Schischmánow, 134.
Schmidt, 110.
Schmidt and Goldscheider, 435.
Schultze, 270.
Schumann, 133, 290.
Séglas and Chaslin, 212.
Shaw, A. B., 375.

Shaw, T. C., 569.
Sherrington, 376.
Sigmund, 208.
Smith, R. P., 569.
Snell, 217..
Spitta, 139.
Staderini, 89.
Steinen, 272.
Steiner, 182.
Strasburger, 100.
Swedenborg, 112, 257.
Sy, 148.

Tallack, 122.
Tanner, 565.
Tarde, 121, 267.
Tarnowski, 251.
Taylor, 258.
Tenchini, 236.
Tillier, 252.
Tilt, 112.
v. Török, 235.
TUCKERMAN, 195.
Tuczek and Cramer, 89.
Tuke, Batty, 596.

Uhthoff, 381.

Vaux, 124.
Verney and Philips (eds.), 121.
Verworn, 126.
Vittum, translator, 557.

Warner, 401.
Warren and Bowditch, 577.
Watase, 189.
Weismann, 102, 104, 105, 106.
Wendt, 567.
Westropp, 256.
Wey, 123.
Wigglesworth, 566.
Wilder, 373, 557.
WILTSE, 144.
Wines, E. C., 240.
Wines, F. H., 394.
WOLFE, 276.
Wolff, 266.
Wright, 403.
Wulf, 90.
Wundt, 374, 431.

Ziehl, 291.